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Status and Future of the Paving in Cold Areas (PICA) Workshops

Ontario

Ministry of Transportation

Research and Development Branch

Technical Report Documentation Page

Status and Future of the Paving in Cold Areas (PICA) Workshops

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Abstract:	The main accomplishments of the PICA Project include three major workshops (in Vancouver, Ottawa and Tsukuba), and published proceedings containing 88 outstanding technical papers associated with "Paving in Cold Areas." Furthermore, the bilateral co-operative initiative developed substantial technical relationships and pavement technology related exchanges and spin-offs. After careful analysis of interest, needs, achievements to date and options for the future direction of the PICA Workshops, it is recommended that the bilateral, co-operative activities between Japan and Canada be continued every 2-3 years hosted by both countries on an alternating basis.
Comments:	The PICA workshops were initiated in 1980 as part of the Japan-Canada Science and Technology Consultations Program. The Ministry of Transportation is a participant and supporting agency.
Key Words:	technology exchange, pavement, cold climates, cracking, low temperature cracking
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- PICA II, Tsukuba 1984
- PICA III, Ottawa 1987

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EXECUTIVE SUMMARY

one decade of successful workshops

The PICA Workshops project was initiated at the 4th Japan-Canada Science and Technology (S&T) Consultations in Tokyo, 1980. The critical review presented here finds this initiative important and relevant to both Japan and Canada which is reflected in the high interest and contribution by paving experts from Government, universities and the private sector of both countries.

significant financial impact

The exploitation and use of new and improved paving technology has a significant impact on the annual expenditure (e.g. $7-8 billion for Canada) which is required to maintain and protect enormous public investment not only in the highway transportation network but also for economic stability and growth.

$350,000 saved

A saving of $350,000 in the cost of resurfacing the main runway at Prince George Airport, B.C. (PWC/AAG award in 1989) demonstrates the type of financial payback which is directly derived from the PICA exchange. This cost reduction was made possible by hot-in-place recycling equipment from Japan. The equipment and technology was obtained from the Taisei Road Construction Company and continues to be used successfully across Canada.

use of high technology

chemistry

With the increase in traffic and loading, the task of the paving experts has become infinitely more complex and sophisticated, especially for cold areas. Simple, empirically based standards are now being replaced by specifications which use "high tech", chemical characterization such as High Resolution Solid State Nuclear Magnetic Resonance (NMR) and computer driven rheogoniometer techniques. The PICA workshops are also dealing with the latest polymer chemistry to improve the rut resistance of pavements and at the same time maintain and enhance their resistance to low temperature cracking. The use of other additives such as silane coupling agents to improve the water resistance in the aggregate-asphalt cement interface is also being studied.

expert systems

Climatic conditions in cold areas (e.g. frost penetration, freeze-thaw, water susceptibility and drainage of base materials and subgrade) require the paving expert to deal with all elements which support the paved surface. His decision and design recommendation affect the entire infrastructure. Therefore, research aimed at the development of high performance pavement structures involves computer modeling techniques and expert systems to correlate and characterize the interaction of material properties, environmental conditions and traffic loading. Much of the input data is obtained and handled by high-tech, automated equipment and data collection systems (e.g. road rakes and weigh-in-motion (WIM)).

accomplishments

The PICA project has been developed jointly, as set out under the bilateral S&T agreement. It has proven to be a very effective forum for the exchange of technology identified by the paving experts as most relevant and of mutual interest. The main accomplishments include: three major workshops - two in Canada (Vancouver and Ottawa) and one Japan (Tsukuba), and published proceedings containing 88 outstanding technical papers associated with "Paving in Cold Areas". Furthermore, the bilateral cooperative initiative resulted in the development of substantial technical relationships, and pavement technology related exchanges and spin-offs.

recommendation to continue

After careful analysis of interest, needs, achievements to date and options for the future direction of the PICA Workshops it is recommended that the bilateral, cooperative activities between Japan and Canada be continued every 2-3 years hosted, on an alternating basis by both Japan and Canada.

1. INTRODUCTION

1.1 Purpose of PICA Review

This account and critical review of PICA - almost ten years after its inception at the 4th Japan-Canada Science and Technology (S&T) Consultations in Tokyo, 1980 - is intended to provide the needed impetus to maintain the support and momentum of this successful project. In addition to the published PICA Proceedings, which mainly describe the activities of the workshops, this report will consider, document and evaluate other cooperative activities and possible spin-offs in terms of relevancy and effectiveness to the overall objective of the S&T exchange program.

A recent survey in Canada (October 1989) by the RTAC Technical Committee, established a need for the Provinces to determine whether the reasons for initiating information exchange on highway paving with Japan are still valid. Some additional questions that should be addressed include:

- What are the achievements to date?
- What sort of results and benefits can be realistically expected?
- Are these immediate or long-term benefits?
- What level of support is justified?

In order to find the answers to these and similar questions one must study the background, the terms of reference, and the underlying objectives of the PICA project.

1.2 Background: Science and Technology Consultations

With the creation of the Ministry of State for Science and Technology (MOSST) in 1971 came the drive for greater cooperation between Japan and Canada. First Minister, Mr. Gillespie, in 1972 led a Canadian delegation (composed of representatives from the provinces) to explore and identify specific projects and areas for cooperation.

The Japanese setting was a heavily populated island country facing immediate challenges to its economic growth (i.e. urbanization, pollution, resources, and secure energy supplies). Hence the efforts in science and technology development were predominantly focussed on commercial application rather than basic research. Thus Japan has gradually become a significant exporter of technology, looking at Canada primarily as a source of raw materials.

The Canadian scene presented a resource-rich, sparsely populated, heterogeneous country of vast expanses with comprehensive links to the U.S. With more emphasis on pure research, Canada relies largely on the U.S. and others for its technology requirements in part through multinational corporations. Although Canada has made a number of significant contributions to the high-technology market (e.g. aerospace), it is still perceived largely as a technology importer.

The development of the framework and basic format for bilateral consultations on science and technology was slow in starting. Difficulties arose for such reasons as inadequate budget for exchange visits, insufficient time to follow formal channels and to reach interdepartmental consensus, inadequate information on both sides, and the presence of bureaucratic officials in the delegation rather than scientists. An Interdepartmental Committee on International Science and Technology Relations (ICISTR) was established in Canada to coordinate and develop policies that would ensure an adequate measure of reciprocity in Science and Technology with other countries.

Although Japan and Canada had different systems and priorities for science and technology development, negotiations progressed with much good will and many exchanges of technology information. An important milestone was the decision to negotiate an agency to agency agreement between the Japanese Society for the Promotion of Science (JSPS) and the National Research Council (NRC) of Canada. This was announced in a Joint Communique during Prime Minister Tanaka's visit to Canada in September 1974 and signed in the following year.

With more visits and a growing awareness of the value of the cooperative program, regular Science and Technology Consultation meetings evolved. The key active areas included offshore structures, space environment and transportation. At the 4th Japan-Canada Consultations on Science and Technology in Tokyo, June 3-6, 1980, the Japanese proposed an information exchange on "Paving in Cold Areas". For this new project Mr. Wm. A. Phang, Head, Pavements and Roadway Office, MTO, was designated as the contact person for Canada and Mr. T. Jijima, Chief, Pavement Division, PWRI, for Japan. Meanwhile discussions continued towards a formal bilateral "Agreement between the Government of Japan and the Government of Canada on Cooperation in Science and Technology". This agreement was completed and signed on May 7, 1986 in Tokyo (Exhibit 1).

1.3 Scope and Organization of Report

The main part of this report will attempt to cover and put on record the following:

- Key elements of the project development;
- Outline of main activities;
- Summary of achievement;
- Suggested future direction and program options;
- Conclusions and recommendations.

The report is based on the chronological sequence of events and collected documents including PICA Proceedings, trip reports, research reports and correspondence (Exhibit 2). The technical papers, a main result of the workshops, have been recorded in three sets of PICA Proceedings and will, therefore, be included and discussed here only by title and main topics. This report is intended to be complimentary to the highly specialized technical activities of the PICA workshops and to be a useful reference by providing a project overview perspective and documentation.

2. PROJECT DEVELOPMENT

2.1 PICA Project Objectives and Mandate

The main and underlying objective for the PICA project is set out in the bilateral agreement:

> "to develop cooperative activities in science and technology in such fields as may be mutually agreed for peaceful purposes on the basis of equality and mutual benefit".

More specific project objectives include the following:

1. To exchange information on research and experience in Japan and Canada on the subject of "Paving in Cold Areas".

2. To deepen the understanding of the state-of-the-art and problems associated with "Paving in Cold Areas.

3. To share information on activities, policies, practices, legislation and regulations concerning research and development.

4. To identify needs and opportunities against which research and development should be directed.

5. To identify and carry out research projects that can be shared between Canadian and Japanese researchers.

6. To visit and exchange scientists, technical personnel, and other experts associated with paving technology.

7. To publish proceedings of workshops and reports on joint projects.

Pursuant to these objectives participation from both the public and private sectors, is being encouraged with the intent of creating mutually productive partnerships.

The initiation of the PICA project and the presentation of the formal mandate took place at the 4th Japan-Canada Consultations on Science and Technology in Tokyo, June 3-4, 1980, as shown in the Record of Decision 7-D:

"The Japanese side's new proposal for information exchange on Paving in Cold Areas was welcomed by the Canadian side which undertook to ask Mr. William Phang of the Ontario Ministry of Transportation and Communications, the contact person, to supply information on Canadian research in this area."

This would set the stage for a decade of technology information exchange between transportation and paving experts from Japan and Canada.

2.2 Terms of Reference and Workshop Framework

The proposal to have PICA included as a candidate project for collaborative activity with concerned Japanese organizations using the facilitating S&T Consultative mechanism, came from the Japanese side. However, it did coincide with one of the proposed subjects suggested by Ontario's Mr. Wm. A. Phang. He was subsequently designated the Canadian contact and focal point for PICA. This appointment was confirmed by Transport Canada who covered transportation related subjects at the Japan-Canada Consultations in Tokyo, June 3-6, 1980 (letter by Mr. P.L. Eggleton, Executive Director, Transport Canada Development, July 28/80).

Later, Mr. Phang, while chairman of the Pavement Technical Committee, engaged the support of the Roads and Transportation Association of Canada (RTAC). As a result of this request, both staff time and resources have been dedicated to furthering and advancement of PICA activities.

The Japanese contact for the PICA project was Mr. T. Jijima, Chief Pavement Section, Public Works Research Institute, Ministry of Construction, Tsukuba. He initially presented the Japanese proposal by explaining that Canada and Japan experience similar problems pertaining to pavements in cold areas (e.g. Hokkaida and the northern part of Honshu). A major concern was the abrasion or wear due to studded tires at an annual cost of $25 million.

The terms of reference for launching the PICA project evolved from the discussions and exchanges between the two sides. The following steps were identified for the development of a collaborative activity of an S&T nature pertaining to Paving in Cold Areas:

1. Canada will supply descriptions of past and current research and procedures used; how pavements research is organized in Canada, and who is involved.

2. Japan will supply similar reports on some of its activities.

3. The initial response will be communicated, and researchers in both countries will be organized and prepared to participate in the corroborative activity.

4. A meeting, likely in Japan, between concerned researchers will be held in which the nature and mechanism of the collaborative activity will be discussed.

5. The possibility and mechanisms of initiating cooperative research activities in "Paving in Cold Areas" will be explored.

6. The possibility of a first PICA workshop in Canada in 1981 will be explored.

In November 1980 Messrs. Wm. A. Phang and I.F. Gilbert, the PICA liaison officer for Transport Canada, visited Japan and, in a joint effort with Mr. T. Jijima and other Japanese researchers, set the stage for information exchange and the framework for the PICA workshops. A detailed description of their visit and observations, including future plans for the PICA project as well as conclusions and recommendations, is documented in their trip report November 7-17, 1980 (Exhibit 3).

In summary, the information exchange visit was quite successful, but very exhaustive with respect to the number of research organizations represented and the amount of subject matter covered. The following organizations and their research centres were included:

- The Science and Technology Agency, an arm of the Prime Minister's Office and the agency representing the Japanese at the S&T Consultations;
- Ministry of Transport, responsible for the airport and the operator of the Port and Harbour Research Institute;
- Ministry of Construction, responsible for highways (except toll roads);
- Tohoku Regional Construction Bureau, a branch of the Ministry of Construction located at Sendai;
- Public Works Research Institute (PWRI), auxiliary organ of the Ministry of Construction located at Tsukuba and contact for PICA through the Chief of Pavement Section (i.e. formerly Mr. T. Iijima and now Mr. Y. Anzaki);
- Civil Engineering Research Institute (CERI), a part of the Hokkaido Development Bureau, Prime Minister's Office;
- Civil Engineering Department, Hokkaido University;
- Faculty of Technology, Kanazawa University.

The information exchange included descriptions and discussions of organizations, research facilities topics pertaining to PICA problems and potential solutions. The exchange also included an information package of research reports, papers and references from each country. Complete listings are given in the trip report by Phang and Gilbert (Exhibit 3, Appendix C and Appendix D).

In general, the exchange visit, although only exploratory in nature, identified PICA problems common to both countries and confirmed the potential benefit arising from a cooperative technology exchange and research program.

3. SUMMARY OF PICA ACTIVITIES

3.1 PICA I - IV Workshops and Published Proceedings

Workshops - The activities of the workshops are documented as PICA Proceedings which have become an acknowledged reference on the subject (Index of Proceedings, Exhibit 4). The topics covered in the three PICA proceedings by a series of high quality, state-of-the-art, technical papers and names of delegates are as follows:

3.1.1 PICA-I, Vancouver 1982

Proceedings, Volume 1 and 2, 754 pages:

Session 1 Low Temperature Cracking
Session 2 Materials and Construction to Overcome Problems of Freezing Soils
Session 3 Frost Penetration and Prevention of Frost Heave in Pavements
Session 4 Reflection Cracking, Prevention and Cure
Session 5 Paving Materials
Session 6 Additive Research

Delegates:

Name	Affiliation
K.O. Anderson	Un. of Alberta, Edmonton, Alta
G.H. Argue	Transport Canada, Ottawa, Ont.
M. Batten	Min. of Transportation, Kingston
R.H. Bjerke	Alberta Transportation, St.Alberta
J.R. Callaghan	Min. Transportation Hwys., Victoria
G.J. Chong	Min. of Transportation, Downsview
R.K. Coates	Public Works Canada, Vancouver
R.W. Culley	Sask. Dept. of Hwys. & Transportation, Regina, Sask.
B.C. Draper	Min. of Transportation & Hwy., Kamploops, B.C.
P.L. Eggleton	Transportation Development Centre, Montreal, Que.
J.J. Emery	TROW Ltd., Rexdale, Ont.
I. Fukushima	Nihon Doro Kopan, Tokyo, Japan
I.F. Gilbert	Transport Canada, Ottawa, Ontario
D.S. Greeley	Dow Chemical Canada Inc., Sarnia
R.C.G. Haas	University of Waterloo, Waterloo
T. Hara	Research Center on Public Works, Tokyo

Name	Affiliation
D.R. Haughton	Min. of Transportation & Highways, Victoria, B.C.
Catherine Hirou	TDC/Transport Canada, Montreal, Que
T. Iijima	Min. of Construction, Ibaraki, Japan
K. Ishigami	Nippon Kokan K.K., Tokyo
Hiroshi Ishii	Dow Kakoh K.K., Tochigi Ken, Japan
Atsuski Kasahara	Hokkaido Institute of Tech., Sapporo, Japan
J.W.G. Kerr	Min. of Trans. Highways of B.C., Victoria, B.C.
J.H. Keyser	Ecole Polytechnique, Montreal, Que.
Ryoji Konno	Japan Society of Rubber in Asphalt, Chuo-Ku, Tokyo
O. Kapvillem	Shell Canada Ltd., Toronto, Ont.
Hiroshi Kubo	Hokkaido Development Agency, Hokkaido, Japan
W.H. MacDonald	Dist. Municipality of Muskoka, Bracebridge, Ont.
J. McDowell	Canadian Embassy, Tokyo, Japan
J.B. MacMaster	Min. of Transportation, Downsview
D.E. Martin	Min. of Transportation and Highways, Victoria, B.C.
Saburo Matsuno	Kanazawa University, Ishikawa, Japan
N.W. McLeod	Asphalt Consultant, Westhill, Ont.
K. Nagai	Nippon Slag Association, Tokyo
S. Numata	Nippon Slag Association, Tokyo
Kenji Ohta	Michireki Chemical Industry Co. Ltd., Tokyo, Japan
Renichi Onishi	Research Lab., Tokyo, Japan
W.A. Phang	Min. of Transportation, Downsview
D.E. Pufahl	Un. of Saskatchewan, Saskatoon,
J. Robinson	Roads and Transportation Association of Canada, Ottawa, Ont.
Takashi Saito	Japan Society of Rubber in Asphalt, Tokyo, Japan
K. Sato	Min. of Transport, Kanagawa, Japan
Teruo Sugaware	Hokkaido University, Sapporo, Japan
Hiroyuki Tada	Japan Road Association, Tokyo
R.G. Todrick	City of Edmonton, Edmonton, Alberta
F.D. Young	Manitoba Dept. of Highways, Winnipeg, Manitoba

3.1.2 PICA-II, Tsukuba 1984

Proceedings, Volume 1, 923 pages:

Session 1 The Highway and Runway Environment and Pavement
Session 2 Evaluation and Pavement Management
Session 3 Pavement Management for Expressways, Urban Systems and to Minimize Degradation
Session 4 Thermal Fracture and Reflection Cracking
Session 5 Laboratory Study of Reflection Cracking
Session 6 Maintenance and Design
Session 7 Improved Materials and Rutting

Delegates:

Name	Affiliation
K.O. Anderson	University of Alberta, Edmonton, Alberta
G.J. Chong	Min. of Transportation, Downsview, Ont.
J.J. Emery	TROW Ltd., Toronto, Ont.
G.H. Heiman	Sask. Highways & Transp., Regina, Sask.
R.C.G. Haas	University of Waterloo, Waterloo, Ont.
J.W.G. Kerr	B.C. Transportation & Hwys. Victoria, B.C.
J. Hode-Keyser	CRCAC Inc., Montreal, Quebec
R. Langlois	Quebec Mini. of Transportation, Quebec
W.A. Phang	Min. of Transportation, Downsview, Ont.
J.B.L. Robinson	RTAC, Ottawa, Ontario
P.L. Eggleton	Canadian Embassy, Tokyo, Ontario
G.J. Kennepohl	Tensar Corp., Toronto, Ontario
M. Brenkmann	Transport Canada, Ottawa, Ontario
H. Kubo	Hokkaido Development, Hokkaido, Japan
M. Yamada	Osaka City University, Osaka, Japan
T. Fukuda	Tohoku University
S. Matsuno	Kanazawa University
T. Watanabe	Tokyo Institute of Technology
K. Sato	Min. of Transport, Japan
M. Onodera	Japan Hwy. Public Corp.
A. Kasahara	Hokkaido Institute of Technology, Hokkaido
T. Koriguchi	Hokkaido Institute of Technology, Hokkaido
Y. Abe	Niohn University, Japan
H. Tada	PWRI, Min. of Construction, Japan
M. Makita	PWRI, Min. of Construction, Japan
T. Iijima	PWRI, Min. of Construction, Japan
M. Okamura	PWRI, Min. of Construction, Japan
R. Shimojima	PWRI, Min. of Construction, Japan
F. Tatsushita	The Institute of Civil Engineering of the Tokyo Metropolitan Government, Tokyo, Japan
T. Sugaware	Hokkaido University, Hokkaido, Japan
M. Inuzuka	Hokkaido Institute of Technology, Japan

3.1.3 PICA III, Ottawa 1987

Proceedings, Volume 1 and 2, 1027 pages:

Session 1 Asphalt Cement for Low Temperature Cracking
Session 2 Low Temperature Cracking
Session 3 Treatment of Transverse Reflection Cracking
Session 4 Maintenance
Session 5 Recycling
Session 6 Pavement Management

Delegates:

Name	Affiliation
Yorimasa Abe	Nihon University, Tokyo
Yoshio Adachi	PWR, Min. of Construction, Ibaraki-ken
S. Akagawa	U.S. Army Cold Regional Research and Engineering Laboratory
Kazuo Amoh	Kajima Road Co.Ltd., Tokyo
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G. Cautillo	Min. of Transportation, Downsview, Ont.
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S. Cheng	Min. of Transportation, Downsview, Ont.
G.J. Chong	Min. of Transportation, Downsview, Ont.
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J.J. Emery	JEGEL, Downsview, Ont.
T.R. Graham	Min. of Transportation, Kingston, Ont.
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K. Hashimoto	Japan Hwy. Public Corp.
G. Heiman	Sask. Hwys. & Transportation, Regina, Sask.
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Kenji Himeno	Tokyo Institute of Technology, Tokyo
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Hisashi Iwata	Japan Hwy. Public Corp., Tokyo Metropolitan
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P. Korgemagi	Min. of Transportation, Downsview, Ont.
Hiroshi Kubo	Hokkaido Development Bureau, Hokkaido
R. Langlois	Min. of Transportation, Quebec
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N.W. McLeod	McAsphalt Eng. Services, West Hill, Ont.
R. McLuckie	Min. of Transportation, North Bay, Ont.

Name	Affiliation
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H. Munford	Min. of Transportation, Thunder Bay, Ont.
Munehiro Murakami	Nichireki Chemical Ind. Co. Ltd. Utsunomiya-City
T.W. Murphy	Min. of Transportation, Kingston, Ont.
Sadao Nagumo	Kumagai Doro Co. Ltd./Japan Road Contractors Association, Yawahara Village
Kouji Nogami	Expressway Technology center Japan, Tokyo
W.A. Phang	Min. of Transportation, Downsview, Ont.
D. Plummer	City of North Battleford
W. Robertson	Esso Canada, Sarnia
K. Sato	Port and Harbour Res. Inst., Min. of Transport, Yokosuka
W. Schenk	K.J. Beamish Constr. Co. Ltd., King City, Ont.
P. Selvadurai	Carleton University, Ottawa, Ont.
Takehiko Suyama	Nippon Hodo Co. Ltd., Tokyo
H. Takallov	
K.K. Tam	Min. of Transportation, Downsview, Ont.
Hitoshi, Tanaka	Maeda Road Co. Ltd., Tokyo
Tetsuo Tanaka	Kajima Road Co. Ltd., Tokyo
R. Taylor	Min. of Transportation, Kingston, Ont.
Masahisa Terao	Taisei Road Constr. Co. Ltd., Tokyo
T. Tomita	FAA
Koushiro Ushijima	Toa Doro Kogyo Co. Ltd., Yokohama, Japan
T. Vincent	U.S. Army Cold Regional Research and Engineering Lab.
T. Vinson	Oregon State University, U.S.A.
Takashi Watanabe	Musashi Institute of Technology, Tokyo
S. White	Saskatchewan Hwys. & Transportation, Regina
Masaru Yamada	Osaka City University, Osaka

3.1.4 PICA IV, Sapporo 1990

3.2. Field Trips

PICA-I, October 1982, Canada

- Field inspection of Chem-Crete Test Section on Hwy. 3, B.C., Canada
- Field inspection of Transverse Crack Suppression Test Section, Hwy. 97, B.C., Canada

Further details are given in the field trip report by Messrs. Meichinger and Draper (Exhibit 5)

PICA-II, October 1984, Japan

- Visit to the construction site of Expo'85, Tokyo
- Field inspection of Joban Expressway Construction
- Visit to Public Works Research Institute, Tsukuba
- Demonstration of field trial construction and inspection of Pavement Test Field, Tsukuba

PICA-III, July 1987, Canada

- Field inspection of Trial Sections with different resurfacing techniques, Hwy. 40, Quebec
- Demonstration of Falling Weight Deflectometer (FWD) by JEGEL, Toronto
- Visit to airport construction site and inspection of hot mix production with recycled asphalt pavement, Lester Pearson Airport, Toronto
- Field inspection of second span construction and rehabilitation of the Burlington Skyway, Queen Elizabeth Way (QEW).

3.3 Joint Research Project

The first phase of a "Common Asphalt Test Program", involving eight participating laboratories in Canada and Japan, has been completed. The results have been compiled and discussed. A final report is now in preparation.

3.4 Exchange Visits

- November 1980 - Messrs. I.F. Gilbert (Transport Canada) and Wm. A. Phang (Province of Ontario) visit Japan: frost heaving, studded tires pavement recycling, seasonal pavement strength variations.

- March-April 1981 - Drs. T. Sugawara (University of Hokkaido) and S. Matsuno (University of Kanazawa) visit Canada: discussion and exchange of written materials on the practices of highway construction, material specification and testing, etc.

- September 1981 - Dr. H. Kubo (CERI) and Mr. H. Ishii (Asaki Dow Co.): extended visit at Montreal, Toronto and University of Waterloo for exchanges on studded tires, skid resistance, test tracks, styrofoam insulation, computer prediction of frost heaving, etc.

- September 1983 - Delegation (36 members) of the Express Highway Research Foundation of Japan to Ontario: highway design, construction, maintenance and operation.

- February 1984 - Mr. M. Murakawa (Environment Agency, Tokyo): policy on studded tires.

- January 1985 - Study group on "Studded Tires" (Mr. K. Takeishi, University of Hokkaido, plus 16 members) visit the Ministry of Transportation, Ontario: policy of snow removal, administration budgeting and expenditures.

- July 1986 - Japan Road Contractors Association (20 members) seminar at Niagara-on-the-Lake. Program and lists of Japanese and Canadian participants are given in Exhibit 6.

3.5 Technology Acquisitions, Transfer and Trade

- October 1982 - Dr. J. Emery (JEGEL) initiates direct technical interaction with Nippon Steel Corp. (Dr. S. Numata) regarding blast furnace and steel slag utilization.

- October 1984 - Visit by Dr. G.J. Kennepohl, Tensar Corp., to Mitsui Petrochemical Industries in Tokyo for the purpose of technology transfer of Tensar Geogrid for pavement reinforcement.

- October 1984 - JEGEL and Taisei Road Construction Co. have an agreement (now in the 5th year) pertaining to the following:

- (a) Taisei Heat Reforming Equipment
  (b) Taisei Expoxy Pavement Patching
  (c) Asphalt/Oil Absorbing Aggregate
  (d) Canadian Fortress Allatt
  (e) Bay Mills Glassgrid Introduction to Japan
  (f) Enhancement of JEGEL Consulting Services through exposure to Taisei technology.

- October 1984 - Dr. G.J. Kennepohl, Tensar Corp. contact Nippon Hodo Co. to exchange Geogrid reinforcement and sulphur-asphalt technology.

- July 1987 - Dynatest FWD introduced to Japanese engineers by JEGEL; development of marketing rights for Dynatest and Pavmatec products in Japan.

4. ACHIEVEMENTS AND BENEFITS

4.1 Meeting the Objectives

A look at the summary of PICA activities clearly shows that the original objectives were met quite handsomely. PICA enjoys an impressive track record. The main accomplishments include three major workshops held in both Canada and Japan and published proceedings to deepen the understanding of the state-of-the-art and problems associated with "Paving in Cold Areas". Thirty-one technical papers have been accepted for the 1990 workshop in Sapporo, Japan.

The first phase of a Common Asphalt Test Program involving eight participating laboratories in Canada and Japan, has been completed. Furthermore, the bilateral cooperative initiative resulted in the development of substantial relationships, pavement technology related exchanges and spin-offs (e.g. use of studded tires, asphalt additives and modifiers, in-situ pavement recycling). Typical examples of individual exchange visit reports are given in Exhibit 7.

Instead of elaborating further on successful technology exchanges, an attempt will be made here to identify and highlight the key achievements and the significant benefits.

4.2 The Real Benefits

Agreed, transportation is a major driving force in our economy. Agreed, the automobile is not doomed as a primary source of transportation in the years to come and we will be spending billions of dollars ($7-8 billion/year in Canada) to maintain, improve and protect our vast investment in pavements which is needed for the increasing traffic demand. In fact, most highway construction funds serve ultimately to provide a safe and reliable pavement surface.

For the highway engineer and the paving expert the more difficult decisions are also associated with the areas of largest financial impact and consequence. The areas are complex and often contain, not unlike some areas in the medical profession, elements of uncertainty and limitations of success. Therefore, it is paramount to the highway program that key technology needs be identified and fostered in a deliberate and persistent manner for long term benefit. At times, it may be easier to succumb to high-profile, novelty, or "hi-tech" ventures which are often only ancilliary to the functional direction of the highway transportation program (e.g. on-board vehicle computers).

The PICA Project, which was prompted by the Japanese and received dedicated support by well recognized Canadian paving experts, including Messrs. Phang, Emery, Haas, Anderson and others, accomplished the following:

1. To focus on key problem areas with significant economic impact and long term potential benefit which are common to Japan and Canada.

2. To create a workshop-like setting for not only systematic search and inquiries to increase scientific and technical knowledge, but also an open discourse and sharing of information and experience on related topics including research approach, anticipated and emerging innovations, policy, procedures, project implementation and management.

3. To provide opportunities and access to projects, construction sites, in-house testing and evaluation facilities in a well staged and organized manner.

4. To carry out joint research projects.

5. To provide a catalyst and forum for technology transfer, acquisition and trade.

5. FUTURE DIRECTION FOR CONTINUED COOPERATIVE ACTIVITIES

5.1 Continued Need

In late 1989, a survey of the provincial transportation departments and past Canadian participants in PICA was conducted by the chairman of the Technical Council of RTAC (Roads and Transportation Association of Canada), Mr. Ian Oliver, "to determine if the reasons of initiating information exchange on highway paving with the Japanese are still valid and the workshop should continue". The survey showed a high degree of interest in the overall program but, concern and difficulties in providing financial support to the delegates.

5.2 Analysis of Options for PICA

Options considered here for the future direction of PICA are as follows:

A. Continue the bilateral, cooperative activities between both countries with workshops every 2-3 years hosted by Japan and Canada on an alternating basis.

B. Suspend the program until *new developments warrant* subsequent workshops.

C. Pursue PICA workshops outside the bilateral agreement on cooperation in Science and Technology between the Government of Japan and Canada by inviting other countries to participate.

D. Discontinue the PICA Project.

The option "D", to discontinue PICA, is not realistic nor advisable because of the level of interest and the success of PICA to date. A lot of effort and goodwill has been expended to develop the special contacts and relationships for effective and genuine exchange. The wasted effort and potential damage for breaking up the relationship must be considered, comparing the situation more visibly to the building of a bridge or highway and then closing it to traffic. This situation would, however, not arise in Canada if the Federal Government (i.e. External Affairs and Transport Canada) and also some of the Provinces would continue to endorse PICA and provide a token sponsorship and support (e.g. the printing of the proceedings and alternately hosting a delegation and/or workshop).

Opening up the exchange, as in option "C", by including other countries with similar climatic conditions, possibly Nordic countries and parts of the United States, has been suggested by the RTAC Board of Directors. While the interest by other countries exists (e.g. U.S. Army Corps of Engineers, Finland and Norway), this move would contravene the bilateral agreement between Canada and Japan. The feasibility of such an expanded format of exchange must be examined in more detail and in collaboration of the respective External Affairs representatives. Mr. Stuart G. Wilson of the North Asia Relations Division (PNR) has already indicated that this option is not in keeping with External Affairs' basic initiative.

The efforts of maintaining a special and intimate relationship would most certainly be diluted and the workshops would become another special interest group with a formal symposium-like forum. If option "C" is elected, the organization and operation of PICA could possibly be integrated into organizations like IRF (International Road Federation) or ISCRD (International Symposium on Cold Region Development).

Suspending the PICA program as outlined in option "B" is not desirable because the spacing between workshops is with 3 year intervals, already very long. The argument that current technology is matured and we need to wait for new developments is very weak indeed. If the reason for suspending PICA temporarily is financial, a reduction of the number of delegates should be considered rather than increasing the time interval between workshops.

The continuation of PICA as a bilateral, cooperative activity between Japan and Canada, as outlined in Option "A" is not only in demand (see section 5.1 "Continued Need") but also feasible and justifiable in terms of return on investment,

e.g. - established need
- largely self-sustaining with modest financial support (only every 2-3 years)
- substantial commitment by delegates to prepare papers, reports and discussions as well as to organize workshops, exchange visits and research projects
- established short and long term benefits
- good private sector participation.

5.3 Funding Requirements

Visitors' Costs

The estimated cost per delegate for a 9-day PICA workshop in Japan is $3,500 to $4,000, depending on the location of residence in Canada. This amount will include all expenses for round trip, accommodation, meals, ground transportation, registration and field trip. In addition, the Canadian delegation requires about $3,500 for a return reception in Japan. The visitors cost will occur only every 4 to 6 years.

Host Costs

The host country is expected to organize the event and cover the cost for printing and issuance of the PICA Proceedings (i.e. about 1000 pages in two soft-cover volumes at an estimated cost of $6,000). Furthermore, the host country or province would sponsor a reception or banquet for the visitors and their accompanying persons. All other events are self-supporting. The host costs will occur only once every 4-6 years.

6. RECOMMENDATIONS

Based on a critical review of the PICA Project, its activities, trade record, status in terms of interest and need, and analysis of options for future direction, the following is recommended:

1. The PICA Workshops be continued under the current bilateral agreement between the Governments of Canada and Japan.

2. Ongoing sponsorship and financial support be developed with the objective to establish guidelines for the continuation and evolution of the PICA project.

3. Joint research projects be encouraged and fostered to solve problems of common interest and importance with respect to economic benefits.

EXHIBIT 1

Agreement Between the Government of Japan and
the Government of Canada on Cooperation in
Science and Technology,
Operational Diagram and Press Release

AGREEMENT BETWEEN THE GOVERNMENT OF JAPAN AND THE GOVERNMENT OF CANADA ON COOPERATION IN SCIENCE AND TECHNOLOGY

The Government of Japan and the Government of Canada (hereinafter referred to as "the Contracting Parties"),

Desiring to strengthen further the close and friendly ties between their two countries,

Recalling the benefits derived from their extensive and successful scientific and technological relationship,

Wishing to broaden the scope of scientific and technological cooperation through the creation of a productive partnership for peaceful purposes and for their mutual benefit,

Reaffirming the desirability of the expansion of scientific and technological cooperation involving entities in the public and private sectors, and

Believing that such cooperation is of advantage in enhancing the quality of life and economic well-being of the peoples of their respective countries,

Have agreed as follows:

ARTICLE I

The Contracting Parties shall develop cooperative activities in science and technology in such fields as may be mutually agreed for peaceful purposes on the basis of equality and mutual benefit.

ARTICLE II

1. Cooperative activities under this Agreement may include:

(a) meetings of various forms, such as those of experts, to discuss and exchange information on scientific and technological aspects of general or specific subjects and to identify research and development projects and programs that may be usefully undertaken on a cooperative basis;

(b) exchange of information on activities, policies, practices, and legislation and regulations concerning research and development;

(c) visits and exchanges of scientists, technical personnel, or other experts on general or specific subjects;

(d) implementation of agreed cooperative projects and programs; and

(e) other forms of cooperative activities as may be mutually agreed.

2. Costs for the cooperative activities under this Agreement shall be borne as may be mutually agreed.

ARTICLE III

1. Implementing arrangements setting forth the details and procedures of the specific cooperative activities under this Agreement may be made between the Contracting Parties or their agencies, whichever is appropriate.

2. Cooperative activities under the Japan-Canada Science and Technology Consultations existing at the time of the entry into force of this Agreement are, in principle, subject to the Agreement.

ARTICLE IV

1. For the purpose of effective implementation of this Agreement, the Contracting Parties shall establish a Joint Committee on Scientific and Technological Cooperation, the functions of which shall be:

(a) to exchange information and views on scientific and technological policy issues;

(b) to review the cooperative activities and accomplishments under this Agreement; and

(c) to provide advice to the Contracting Parties with regard to the implementation of this Agreement and the orientation of the cooperative activities thereunder.

2. The Joint Committee shall meet in principle every two years alternately in Japan and Canada at mutually agreed times.

ARTICLE V

The provisions of this Agreement shall be subject to the laws and regulations in force in each country.

ARTICLE VI

Each Contracting Party shall accord to the persons carrying out the cooperative activities

under this Agreement all possible facilities.

ARTICLE VII

1. Scientific and technological information of a non-proprietary nature arising from the co-operative activities under this Agreement may be made available to the public in accordance with the normal procedures.

2. The Contracting Parties will give due consideration to the protection and the distribution of intellectual property rights or other rights of a proprietary nature resulting from the cooperative activities under this Agreement and will consult with each other for this purpose as necessary.

ARTICLE VIII

Nothing in this Agreement shall be construed to prejudice other agreements for cooperation between the Contracting Parties, existing at the date of signature of this Agreement or concluded thereafter.

ARTICLE IX

1. This Agreement shall enter into force on the date of signature thereof. It shall remain in force for three years and will continue in force thereafter unless terminated by either Contracting Party at the end of the initial three-year period or at any time thereafter by giving to the other Contracting Party at least six months' written advance notice of its intention to terminate this Agreement.

2. The termination of this Agreement shall not affect the carrying out of any project or program undertaken under this Agreement and not fully executed at the time of the termination of this Agreement.

DONE at Tokyo on the seventh day of May, 1986, in duplicate in the Japanese, English and French languages, each version being equally authentic.

For the Government of Japan:

Shintaro Abe

For the Government of Canada:

Agreed Minutes

The representatives of the Government of Japan and the Government of Canada have reached the following agreement during the negotiations for the Agreement between the Government of Japan and the Government of Canada on Co-operation in Science and Technology:

With respect to the cooperative activities referred to in Articles I and II of the Agreement, the Contracting Parties may, as appropriate, be supported by entities in both the public and private sectors in accordance with the laws and regulations in force in each country.

Tokyo, May 7, 1986

For the Government of Japan:

Shintaro Abe

For the Government of Canada:

Office of the Prime Minister

CANADA

Cabinet du Premier ministre

Release

Date: May 7, 1986

For release: Immediate

CANADA-JAPAN AGREEMENT ON COOPERATION IN SCIENCE AND TECHNOLOGY

Prime Minister Brian Mulroney today announced that the Governments of Canada and Japan have concluded a bilateral Agreement on Cooperation in Science and Technology.

The Agreement signed today by Foreign Minister Shintaro Abe and Canadian Ambassador to Japan, Barry C. Steers, sets out the objectives of both countries in the bilateral science and technology relationship and provides for the expansion of a broad range of cooperative initiatives.

The Prime Minister also announced that the first meeting of the Joint Committee on Scientific and Technological Cooperation under this Agreement will be held in Vancouver September 26 to 28. The Joint Committee will review existing projects and discuss new proposals for both countries.

The Agreement will build upon the substantial relationship in science and technology which has developed steadily between the two countries over the years.

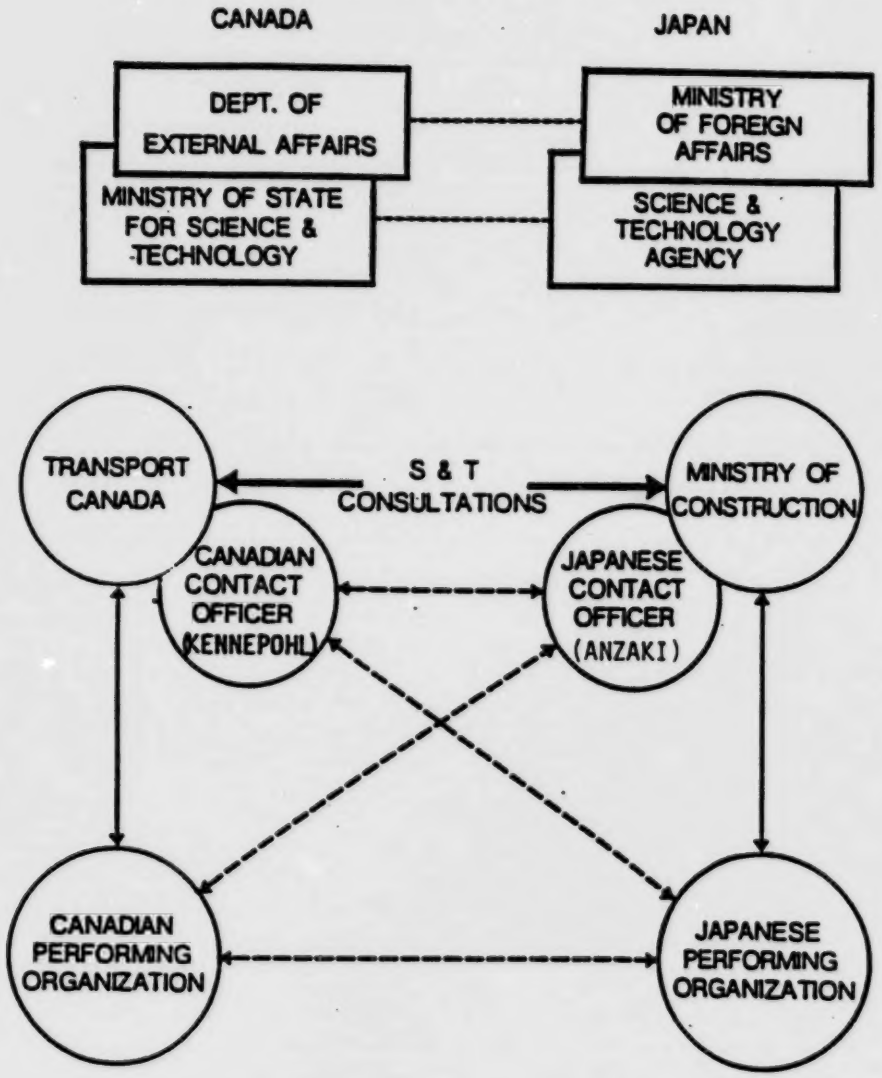
There are currently some 75 joint projects recognized under a bilateral consultative process which has been in place for more than a decade. The Prime Minister stated that he expects important new benefits to accrue to the participating government organizations which will be supported, as appropriate, in cooperative activities by entities in both the public and the private sectors.

Prime Minister Mulroney and Prime Minister Nakasone assigned the highest priority to the early conclusion of the Agreement when they met in Ottawa last January.

FIGURE 1

CANADA/JAPAN SCIENCE & TECNOLOGY
CONSULTATIONS

PICA OPERATIONAL DIAGRAM



LINKAGES ——— linked by S&T Consultations
——— linked contractually
- - - - - informal linkages facilitated by S&T

COOPERATIVE MEANS: Attendance at progress reviews and workshops
Joint assessment of alternative techniques
Sharing of work elements of a common project

EXHIBIT 2

SELECTED PICA PROJECT DOCUMENTS

1.	May 29/80	Letter of Welcome of Canadian Delegation to 4th S&T Consultations, Tokyo, by Canadian Ambassador, Brucke Rankin.
2.	June 3-4/80	Record of Decision, 4th Japan-Canada Consultations on Science and Technology: PICA proposed by Japanese.
3.	June 3-6/80	Letter of External Affairs to Ontario Intergovernmental Affairs: Summary Report.
4.	July 28/88	Letter to Wm. Phang from Transport Canada: Wm. Phang designated as Canadian Contact endorsement by D. Hobbs, Deputy Minister, MTO.
5.	Sept. 8/80	Letter to Wm. Phang from P.W.R.I., Mr. T. Iijima, Japanese designated contact: Planning and Preparation of PICA project.
6.	Sept. 9/80	Transport Canada Memo from P.L. Eggleton to I. Gilbert, re: Project Proposals: a) Hot Mix Recycling of Asphalt Pavements; b) Asphalt Cement Additives and Extenders.
7.	Oct. 6/80	MTO Memo: Wm. Phang's preliminary visit to Japan, November 3/80.
8.	Oct. 14/80	Transport Canada Memo: Briefing Book for Visit to Japan - Peter L. Eggleton.
9.	Oct. 27/80	Letter from Transport Canada to MTO: Cost Sharing Agreement (No. 104027) to apply for Mr. Phang's visit to Japan.
10.	Oct. 29/80	Letter from Canadian Embassy, Tokyo: Itinerary for Mr. Phang.
11.	Nov. 1-25/80	Four Trip Reports (2 preliminary, 2 comprehensive) by Messrs. Phang and Gilbert: Visit to Japan, November 1-14/80.
12.	Dec. 11/80	Letter from Transport Canada to Foreign Affairs (S&T Office): Draft for PICA Agreement.

13.	Dec. 16/80	Letter from Wm. Phang, MTO, to Transport Canada: Note on Skid Resistance Testing in Japan, November 1980.
14.	Dec. 27/80	Letter from P.W.R.I., T. Iijima to MTO: received 2 films on studded tires.
15.	May 8/81	Letter from Wm. Phang: Visit by Dr. H. Kubo regarding Studded Tires.
16.	Aug. 25/81	4th Canada-Japan Consultation in Science and Technology, Tokyo, 1980: Progress Report.
17.	Sept. 15/81	Paving in Cold Areas: Propose Mini Workshop Outline.
18.	Nov. 26/81	External Affairs Mid-term Review of Canada-Japan Consultations.
19.	Dec. 7/81 to Feb. 6/82	Joint Research Project Agreement
20.	Jan. 26/82	Letter from H. Ishii (Dow): Toyota Test Road with Styrofoam.
21.	Feb. 26-27/82	Telex: Multilateral Initiative for Cold Regions?
22.	Mar-Apr/82	Memo from Transport Canada: Preparation for 5th S&T Consultation, June 14-15/82, Ottawa.
23.	Apr. 21/82	Letter from MTO to External Affairs: Topics for Japan-Canada S&T Consultations.
24.	Sept. 13/82	Memo from Transport Canada: Sebastyan & Oct. 28/82 airports to be included in PICA.
25.	Oct. 28/82	Memo from Transport: PICA-I Highlights.
26.	Feb. 9/83	Telex: Dr. Robinson to Japan.
27.	Feb. 16/83	Telex to H. Ishii (Dow): Studded Tires.
28.	Sept. 21/83	Express Highway Research Foundation of Japan: Visit to MTO.

29.	Oct. 13/83	Letter from External Affairs: Japan-Canada S&T Consultations: Review Meeting.
30.	Oct. 18/83	PICA II Kick-off correspondence.
31.	Oct. 24/83	Wm. Phang: Project Activity Sheet (Japan-Canada S&T Consultations).
32.	Nov. 1/83	Request from H. Ishii for "Computer Prediction of Frost Penetration".
33.	Nov. 24/83	Telex: Info on Magnetic Levitation and Image Processing.
34.	Nov. 28/83	Letter from Foreign Affairs: Review Meeting.
35.	Dec. 16-22/83	Preparation of PICA ~ More Canadian industry participation; sponsorship, call for papers.
36.	Jan./84	Preparation of PICA ~ industry participation, $18,000 support, paper submission .
37.	Feb./84	Letter from Consulate General of Japan, Toronto: Visitor from Automobile Pollution, Government of Japan.
38.	Feb/Sept/84 June 11/84	Preparation of PICA-II 4th S&T Consultation Preparation Review
39.	July/Oct/84	Correspondence with H. Kubo, CERI: Phang and Keyser to Sapporo after PICA-II.
40.	Oct.31/84	Letter from RTAC: PICA benefits?
41.	Jan. 28/85	Visit of Japanese delegation re. Studded Tires.
42.	Feb. 25/85	Visit of Japanese Commercial Affair Altadie.
43.	Mar. 12/85	PICA-II Reports.

EXHIBIT 3

Report on Visit to Japan, Wm. A. Phang and I.F. Gilbert

REPORT ON VISIT TO JAPAN

November 7 - 14, 1980

By

W.A. PHANG
Head, Pavement Research
Ministry of Transportation
and Communications,
Ontario

and

IAN F. GILBERT
Senior Development Officer
Transportation Development Centre
Transport Canada

To

Investigate problems common to Canada and Japan
related to highway paving in cold areas (PICA).

Sapporo
HOKKAIDO
Japan Sea
Pacific Ocean
Sendai
Kanazawa
HONSHU
Tokyo
SHIKOKU
KYUSHU

1. Introduction

At the 4th Canada/Japan Consultations on Science and Technology in Tokyo, June 3 - 4, 1980, it was decided that a formal program would be initiated to exchange information and carry out joint research related to highway Paving in Cold Areas. At the request of Transport Canada, Mr. William Phang of the Ontario Ministry of Transportation and Communications was asked to serve as the contact point for Canada, and Mr. T. Iijima of the Public Works Research Institute, Ministry of Construction was designated to fill that role for Japan. Mr. Ian Gilbert of the Transportation Development Centre was assigned to act as the Transport Canada coordinator.

During the succeeding few months communication was established between Phang and Iijima and each side identified several problem areas peculiar to its own circumstance and concerning which it would welcome information exchange. Typical problem areas, which could provide the basis for initial cooperative research, were identified as follows:

by Japan:
- Frost heaving
- Pavement abrasion by studded tires

by Canada:
- Flexible pavement recycling
- Seasonal pavement strength variation.

While Phang and Iijima were collecting material for exchange on the above noted subjects, the need arose for Gilbert to visit Japan on unrelated business. It was decided to use this opportunity for Phang and Gilbert to undertake a tour of Japanese road research facilities; thereby accelerating the establishment of a cooperative joint research program between our two countries.

This report describes the elements and results of that visit.

2. Planning

Preparation for the trip involved the development of an itinerary and the booking of travel and accommodation arrangements while in Japan. All of this detail was (most efficiently) taken care of by the Science and Technology Office of the Tokyo Embassy. The Science Counsellor, Mr. Joseph MacDowall also ensured that at each point of call, at least one has had sufficient knowledge of English to provide interpretation service. Pre-trip preparation also included the assembly of slides and documentary hand-outs to be used at each point of call.

2.1 Itinerary

The tour, which covered the six working days between Nov. 7 and Nov. 14, is outlined in detail in the Embassy document "Program and Logistics", attached as Appendix "A". In summary it involved visits to the cities of Tokyo, Tsukuba, Sendai, Sapporo and Kanazawa. Offices and institutions visited included the Ministry of Transport; the Ministry of Construction; the Public Works Research Institute; the Tohuku Area Building Inspection Office; the Civil Engineering Research Institute of the Hokkaido Development Bureau; the Civil Engineering Department, University of Hokkaido; and the Faculty of Technology, Kanazawa University. A complete listing of these points of call, and the personnel involved is attached as Appendix "B".

2.2 Documentation

Literature searches were carried out on the two subject areas of studded tire wear and frost heave, by M.T.C. library, and by RTAC library. A number of reports were selected from these searches, and copies obtained for transmittal. Lists of those reports presented to Mr. Iijima, to Dr. Sugawara, to Dr. Fukuda, and to Dr. Matsuno, are attached as Appendix "C".

Additionally, three slide presentations were prepared:-

1) A summarization of Canadian research in laboratory and field of studded tire wear resistant mixes.

2) A condensation of identification of frost heave damage, prediction of frost penetration, design practices to minimize frost damage, and design of insulation to correct frost heaves.

3) An outline of hot-mix recycling practices.

Because of time constraints the slides were made in English only. However, Japanese translations of some of the slide material were completed just prior to the visit, and Xerox copies of these were prepared for distribution during slide presentations.

3. Visit Details

3.1 Points of Call

- The Science and Technology Agency is an arm of the Prime Minister's Office. It is this Agency which represented the Japan side at the 4th Japan-Canada Science and Technology Consultations. The director Mr. Hayashi, was pleased at our visit as tangile evidence of progress in implementation of the decisions of the Consultations.

- The Ministry of Transport has responsibility for construction and maintenance of airports. We were received by the Director and staff from the Construction Division and the Soils Division (Port and Harbour Research Institute). One of their major concerns is prevention of accidents due to planes skidding off the ends of the runways because of ice.

- The Ministry of Construction has responsibility for construction and maintenance of highways (except toll roads). We were received by their International Affairs Division Director, Overseas Cooperation Officer, and Chief, Pavement Section.

- The Tohoku Regional Construction Bureau is the local branch of the Ministry of Construction, located in Sendai. We were received by the Directors of the Road Division and the Construction Office. They arranged for us to visit a test road at Shiroshi, and the Tohoku Region Research Center in Sendai. Their major PICA problems were rutting distortion and studded tire wear.

- The Public Works Research Institute at Tsukuba, is an auxiliary organ of the Ministry of Construction. The Road Department is one of 12 Departments at the Institute. The contact point for PICA, Mr. T. Iijima is Chief, Pavement Section. Mr. Iijima identified two PICA problem areas and the Japanese researchers who were most involved in these areas. We were received by the Director General of the Institute,

the Deputy Head of the Planning Division, and the Directors of the Road Department, and the Geology and Chemistry Department. It was indicated that the Institute would support cooperative research activity resulting from the PICA discussions during our visit. Mr. Iijima arranged for us to visit the laboratories (Chemistry) where work on asphalt and asphalt mixes were being carried out, and to visit the pavement test track where various pavement and mix designs were being tested by loaded trucks directed by remote control.

- The Civil Engineering Research Institute, a part of the Hokkaido Development Bureau, Prime Minister's Office, is located in Sapporo, Hokkaido. We were met by the Chief, Pavement Laboratory, and shown the latest version of the Bibi Test Road. The experiment involved monitoring of seasonal strength variation by means of buried plates, and prevention of reflection cracks.

- The Civil Engineering Department, Hokkaido University, is located in Sapporo. We were met by Professors Sugawara and Moriyoshi, who had been working on PICA problems for many years. The University Laboratories were extensive, and had automated equipment for testing basic properties of asphalt and asphalt mixes, and for studying studded tire wear. The University is also active in skid resistance and tire/pavement interaction studies, and has developed specialized equipment for continuous friction testing at highway speeds.

- The Faculty of Technology, Kanazawa University, has no specialized pavement testing laboratory. Professor Matsuno, formerly Chief, Pavement Section, PWRI, (same position now held by contact point, T. Iijima) has been working on treatment of cracks and prevention of reflection cracking, with the local highway agencies.

3.2 Research Facilities

- Port and Harbour Research Institute,
  Ministry of Transport,
  1-1 Nagasa 3 Chome, Yokosuka-shi,
  Kanagawa-ken, Japan.

The Ministry of Transport has responsibility for providing and maintaining Ports and Harbours in Japan, including airport facilities. The interest of the Ministry of Transport in the 'Paving in Cold Areas' (PICA) project, was from the point of view of airport pavements, more specifically, in the problem of 'icing' of runways. Their laboratories are located in Yokohama, and include a circular test track and a tractor driven 'loading cart' which can apply 100 tonne loads at speeds up to 30 km/h. Their research programs include the following:-

- Characteristics of Aircraft loads to pavements.
- Stability and Durability problems of subgrade and base course under repeated loading.
- Structural design and construction methods for airport pavements.
- Evaluation methods of airport pavements.
- Planning and construction methods for offshore airports.

The laboratory equipment available includes a testing tank for loading pavements with static and dynamic wheel loads, and repeated loading triaxial apparatus with automatic recording devices.

Skid safety is being evaluated with a Mu-meter.

Mr. Fukute, a researcher in the Runways Laboratory, recently attended the University of British Columbia, Vancouver.

The facilities are modern and utilize a great deal of sophisticated electronic equipment. There appears to be no lack of project funds.

- The Public Works Research Institute (PWRI),
  Ministry of Construction,
  Tsukuba.

The Ministry of Construction is responsible for Japan's highways, except those which come under the toll road system. The PWRI facilities at Tsukuba were completed at the end of March 1980, at a cost of about $246 million.

The operational budget is about $14.5 million per year, of which Roads attracted 24% in 1980.

The Pavement Division of the Road Department has a large program of material and pavement structure testing, evaluation, standards, maintenance, etc., and is ably supported by the Chemistry Division in its work on application of polymer materials to pavements. In this latter work, the Chemistry laboratory is equipped with very modern, automated equipment of all types, from the simple asphalt cement penetrometer, to complex wheel tracking tests. Specimen can be prepared by Marshall, Gyratory, and by roller segments for beams and slabs. Mixes are prepared in a large electrically heated pot. The Pavement Division operates a pavement test track where the loading is applied by two trucks operating under programmed remote control from a central control tower. The track is being expanded by introducing a smaller diameter track hooked into the larger oval shaped track. All of the equipment uses sophisticated electronic hardware. The PWRI has its own computer and computer graphics section, and extensive library facilities. The high quality laboratories and testing facilities are adequately staffed with skilled personnel, and there does not appear to be any lack of funding for projects.

- The Tohoku Research Center,
  Ministry of Construction,
  Sendai.

  The Tohoku Region of the Ministry of Construction is a regional office directly responsible for carrying out construction and maintenance work. The Tohoku Research Center supports the Regional construction and maintenance activities through quality assurance testing, equipment performance testing, measurement and evaluation of various laboratory and field experiments, etc.

  The laboratory for asphalt mixes has equipment for mix design, and for the preparation and testing of pavement slabs for rutting resistance and for wear by chains. The facilities are located in quite a restricted laboratory space.

  The Shorioshi Test Road - with test sections of asphalt mix containing different additives such as polymers, resins, etc., to increase resistance to rutting and wear by chains, has had under 2-years of traffic. One of the test sections which was inspected during our visit had failed in fatigue in the wheel track, and exhibited very severe spalling indicative of brittleness.

  The environmental conditions around Sendai were not considered as being suitable for field investigations for low temperature problems.

- The Civil Engineering Research Institute (CERI),
  Hokkaido Development Bureau,
  Sapporo.

  The Hokkaido Development Bureau, established by the office of the Prime Minister, is responsible for guiding the development of Hokkaido, the northernmost island in Japan, with a population of

about 5,000,000 people. The Pavement Laboratory of CERI has been actively engaged in full-scale testing of materials and techniques to cope with problems directly related to PICA. The Bibi Test Road has recently been completely rebuilt to test seasonal strength variation of some different materials, and to test proposed solutions to reflection cracking due to low temperatures. Dr. Kubo, chief of the Pavement Laboratory has a great deal of experience in the subject. Funding of research projects did not appear to pose any problems.

- The Civil Engineering Department,
  Hokkaido University,
  Sapporo.

The Hokkaido University is over 100 years old, and Professor Teruo Sugawara, Civil Engineering Department, has specialized in the field of materials and testing for pavements. Mr. Iijima, and Dr. Kubo, are both former graduates of Hokkaido University.

Dr. Sugawara, ably assisted by Dr. Moriyoshi, are currently working on basic stiffness parameters of asphaltic materials and mixes, with equipment designed and built in their workshops. Additionally, their laboratories are equipped for repetitive four point beam flexure fatigue testing, low temperature fracture testing, as well as equipment for wheel tracking tests, and wear by tire chains. The equipment is modern and the technology is sophisticated.

Dr. Sugawara, is a leader in research in the asphalt paving field in Japan, and does influence the direction research in pavements in Japan takes, and is a potential asset to any joint project which might be undertaken in PICA. Cold temperature research should certainly be carried out in Hokkaido, since the winters here are similar in severity to that experienced in southern and central Ontario.

- The Faculty of Technology,
  Kanazawa University.

  The Kanazawa University has not yet developed the first class laboratory facilities for pavement research. Dr. Matsuno, formerly Chief, Pavement Division, PWRI, works with the Regional Ministry of Construction staff. His efforts have been directed towards field evaluation of performance of materials and techniques to avoid reflection cracking. The environmental differences at Kanazawa, make it a useful location for testing of this nature.

- Recycling Facilities,
  Sapporo City.

  In response to one of our requests to learn about the recycling of asphalt pavements in Japan, a visit was arranged to two plant sites in Sapporo city, where hot-mix recycling was being done.

  At one plant, the slabs of salvaged pavement were loaded into covered hoppers in which steam was piped, and allowed to sit for about 40 minutes before being discharged. The discharged material, all broken down, but wet with moisture, was then passed through a drum dryer equipped with a burner which had been shifted back from the drum, as in a Boeing Pyrocone. The material emerging from the hot-mixing process was not added to in any way to change or control its properties. It was being reused as a 100 percent recycled base material, reportedly with good success.

  At another site, an experimental drum was being tested, which would replace the covered hoppers as the vessel in which the pavement slabs would be broken down by steam. The drum rotated, and as well it had rotating paddles in the drum to break down the slabs more quickly. The broken down product was really saturated in this process. Further details about the process were not easy to obtain because of time and language constraints.

4. Visit Agenda

4.1 Information Exchange

The main item of business at each meeting was the exchange of information on specific problems in PICA. The Canadian side first listened to the Japanese side presentation of their organization, research facilities, and results of their research in the two PICA topics of low temperature problems and studded tire wear, and accepted brochures and English language synopses of their work. Then the Canadian side presented the results of Canadian research in these subject areas by oral presentations and by copies of reports (see Appendix C). Discussion of the Canadian research then took place. The impression was gained that the Japanese were in substantial agreement with Canadian research, and that guidelines presented would be carefully looked at. Because of time constraints it was not always possible to present all of the three slide presentations at each meeting. Appendix "D" contains a list of Japanese reports submitted to the Canadian side. Copies of these reports will be made available to Canadian researchers at a later date.

It was the Canadian side impression that the Japanese had done a great deal of basic work, some of it duplicating work already done elsewhere in other forms. It was the Canadian side impression also that mechanisms were in place for translating research findings into specifications etc., and further that there is a great deal of work complementary to current Canadian research being carried out in PICA and in other related areas which would be useful for Canada.

4.2 PICA Problems

During the course of the visits to the test road sites at Shiroshi (near Sendai) and Bibi (near Sapporo), the condition of pavements travelled over did indeed reveal that rutting deformation and studded tire wear were major problems.

Structurally, pavements on the National highway system are more than adequate from a thickness standpoint. (Thickness design for a road with more than 3000 heavy commercial vehicle per day in one direction, on a 3 CBR subgrade, would have an equivalent asphalt thickness T_A of 45 cm, or a total thickness of 83 cm (33 in.) with a minimum thickness of surface and binder courses of 20 cm (8 in.). However the trucks which are used in Japan are generally straight trucks with either single or tandem rear axles. The legal axle load is 10 tonnes but there still is a fair percentage of overloaded axles. There appears to be some concern that truck tire pressures were too high, being about 100 - 120 psi.

Mixes generally used are fine gap graded with about 4% filler and more than 7% asphalt cement. An asphalt cement of about 70 pen. grade is used. This type of mix has high stabilities with high flows (> 20). The mix ruts under heavy traffic at high temperatures, but there are few signs of cracking in the wheel tracks even when the ruts are excessive (> 5cm).

In snow and ice areas, such as Sapporo, every vehicle is fitted with studded tires during the winter, including trucks and buses. Not all vehicles remove their studded tires in summer. As a result some streets in Sapporo have deep channels for wheel tracks (> 7cm) and the centerline looks like an island. Studded tire damage in Hokkaido alone is estimated at over $5 million/year.

Other problems such as surface course cracks and spalls in the wheel track, construction joints, reflection cracking, low temperature cracking, and the efforts being made to overcome them were discussed.

4.2 Cooperative Research

As a result of discussion of problem areas it became evident that there were common (Japan/Canada) problems which were being addressed by both sides in different ways. These were:-

(a) the development of solutions to the problem of rutting were being investigated.

in Canada	in Japan
by use of sulphur extended mixes	by use of plastics fillers
Carbon Black fillers, reclaimed Rubber	epoxy/asphalts latex

This side by side comparison clearly indicates that cooperative research on the subject of "Additives to provide desired improved material properties for PICA" would be useful to both Canada and Japan.

(b) the development of solutions to the treatment of cracks, and the prevention of reflection cracks were also being investigated by both Canada and Japan. Both sides were looking at different crack filler materials, and at materials to bridge over old cracks to prevent reflection cracks in new overlays. This subject area was being investigated at the Bibi test road using different crack spacings, and 'slip plane' crack bridging material. Tests were also being conducted at Kanazawa with materials like asphalt shingles etc. In Ontario, two test areas with various crack filling materials are under test; various reflection crack prevention materials are also under trial in Ontario and other provinces. Again, the parallel efforts in "treatment of cracks and prevention of reflection cracks" make this area an obvious choice for cooperative research.

Details of these projects will need to be worked out. For example the methods of measurement, the methods of test, etc. have to be mutually agreed on for the results from each side to be compared with confidence. The properties to be measured have to be agreed on. The objectives of the program, the extent of testing, etc. will have to be worked out. The time scale, and who does what, have to be settled.

Both sides believed that funding for this research would be available through normal channels.

It is proposed to have some of this material clarified by correspondence. However, there will be an opportunity to meet with two Japanese researchers, Mr. Sato, Ministry of Transport, and Dr. Sugawara, University of Hokkaido, when they visit North America (Purdue University) next April 1981. At which time much of the details can be discussed and agreed upon.

5. Future Plans

It was agreed that an essential part of the cooperative research was not only exchange of written reports on the results of the research, but the opportunity to meet and have face-to-face in-depth discussion on a broader front than is possible through written reports.

The subject of having mini-workshops involving say 4-6 researchers from each side, was discussed. One in Canada and one in Japan, at perhaps 2-year intervals, was considered a reasonable objective to aim for. Travel funds for this purpose were unlikely to be available from normal budget sources, both in Japan and in Canada. This should be recognized as a need at the Federal level and perhaps satisfied through the Science and Technology agency. This need is modest in scope, probably about $30,000.

The benefits to be gained in these particular co-operative projects are difficult to quantify at this stage, but there is no doubt that Japan is spending a great deal on research in a broad spectrum of transportation research and that they are willing to extend this program in other areas. A cooperative project in this area may well create the opportunity to become involved in cooperative research in other areas.

6. Conclusions and Recommendations

In general it can be concluded that this trip, exploratory in nature, was highly successful in setting the stage for future cooperative research, between Canada and Japan, related to highway paving in cold areas. It also identified specific problems, common to both countries, which would be logical candidates for initial joint research projects, as well as the action necessary for their implementation. This can be summarized as follows:

6.1 Conclusions

- Japan has excellent research facilities and resources for highway pavement research and appears most willing to cooperate with Canada in joint research activities.
- The potential benefits to Canada from such activity would be considerable.
- The two most appropriate areas for initial joint research are:
  - "Additives to Attain Desirable Properties for Paving in Cold Areas", and
  - "Treatment of Cracks and Prevention of Reflection Cracking".

6.2 Recommendations

- A Joint Research Project Agreement be negotiated between Transport Canada and the Ministry of Construction, Japan, to undertake these initial research projects.
- A working group of Canadian researchers be identified to develop cooperative research plans.
- A source of funding be identified to facilitate the continuation of information exchange, specifically through the organization of mini-workshops, alternately in Canada and Japan on a regular basis.

S&T CONSULTS. FOLLOW-UP:
Paving in Cold Area Mission - William Phang & Ian Gilbert

PROGRAM AND LOGISTICS

Phang
Gilbert
T. Iijima, Public Res. I
MacDowall
Tanaka
Nakajima

Time/Date	Program (Move/Location)	Emb. Support	Transportation	Remarks
Nov. 7 Friday				
	Tohoku Area Building Inspection Office Mr. Misaki of Road Management will meet			
	Tohoku University Dr. Murai, assistant prof. will meet			
	Stay at Sendai Plaza Hotel			0222-62-71
Nov. 8 Saturday				
0958	JNR L-express Hibari No. 10 leaves Sendai (tentative).		JNR	
1413	The train arrives Ueno Station Stay at Ginza Daiichi Hotel			
NOV. 9 Sunday	Stay at Ginza Daiichi Hotel			
			Taxi	Hotel 542
Nov. 10 Monday	Courtesy call to STA			
0905	Tanaka is picked up at S&T Office	Tanaka		
0920	Messrs. Phang & Gilbert are picked up at Hotel lobby			
0940	Meeting with Mr. Hayashi, Director, International Division, Science and Technology Agency			Mr. Shig Internatio Div. 581-5 STA
0955	leave STA			
1005	Courtesy Call to Min of Transport Arrive Ministry of Transport Mr. Abe, Construction Division, Aerodrome Department receives and guides the mission	Tanaka		
1055	leave MOT			

[redacted] Distribution [redacted]

PROGRAM AND LOGISTICS

Time/Date	Program (Move/Location)	Emb. Support	Transportation	Remarks
Nov. 10 Monday 1105	Courtesy call to Min. of Construction Arrive MOC Mr. Hokura, International Division receives the mission	Tanaka		
1200	Lunch			
1407	Leave for Ueno Station			
1507	JNR express Tokiwa No. 9 leaves from Truck 10 of Ueno Station			
1605	Arrive Tsuchiura Stay at Sun Route Hotel, Tsukuba			
Nov. 11 Tuesday PM=	Visit to Public Works Research Institute			0298-52-11 SB
PM	Return to Tokyo Stay at Ginza Daiichi Hotel			Hereafter a arrangement made by Dr. Takashi Ii, Public Work Res. Inst. 0298-64-22
Nov. 12 Wednesday	Visit to Sapporo Public Work Testing Station and Hokkaido Universit		Embassy car	
0730	Leave hotel			
0930	JAL 505 leaves Haneda Airport			
1100	The plane arrives at Chitpse Airport near Sapporo City Meeting with Mr. Kubo at the Sapporo Public Work Testing Station			
Nov. 13, Thurs.	Meeting with Mr. Sugawara, Professor, Hokkaido University Technolo			011-711-2
1800	ANA 716 leaves Chitose Airport			
1935	The plane arrives at Komatsu Airport near Kanazawa			

PROGRAM AND LOGISTICS

Time/Date	Program (Move/Location)	Emb. Support	Transportation	Remarks
Nov. 14 Friday	Visit to Kanazawa University Meeting with Prof. Matsuno			
1505	ANA 758 leaves Komatsu Airport			
1615	The plane arrives at Haneda Airport Stay at Ginza Daiichi Hotel			
Nov. 15 Saturday	Leave Japan			

APPENDIX "B"

JAPANESE PERSONNEL VISITED

1. SCIENCE AND TECHNOLOGY AGENCY, TOKYO

Mr. Hikaru Hayashi
Director, International Affairs Division

2. MINISTRY OF TRANSPORT, TOKYO

Mr. Haruo Inoue
Director, Construction Division
Aerodrome Dept.
Civil Aviation Bureau

Mr. Yohichi Abe
Special Assistant to Mr. Inoue

Mr. Katsuhisa Sato
Chief, Runways Laboratory
Port and Harbour Research Institute

Mr. Tsutomu Fukute
Soils Division
Port and Harbour Research Institu

3. MINISTRY OF CONSTRUCTION, TOKYO

Mr. Makato Okamura
Chief, Pavement Section
Road Bureau

Mr. Shunich Hokura
Overseas Cooperation Officer

Dr. Hiroshi Mitani
Director, International Affairs Division
Planning Bureau

4. PUBLIC WORKS RESEARCH INSTITUTE, TSUKUBA (M.O.C.)

Mr. Yoshijiro Sakagami
Director General

Mr. T. Okuba
Deputy Director General

Mr. T. Iijima
Chief, Pavement Section
Road Division

Mr. Tomio Muto
Deputy Head, Planning Division

Mr. Minoru Makita
Director, Geology and Chemistry Dept.

5. TOHOKU REGIONAL BUREAU (M.O.C.) SENDAI

Mr. Kazuo Ohshima
Director, Road Division

Mr. Akira Komuro
Director, Construction Office
Akita Region

Mr. Yoshihisa Hoshino
Geologist

Mr. Shigeru Komai
Urban Planner

Mr. Yutaka Minato
Vice-Director
Tohoku Research Centre

6. HOKKAIDO DEVELOPMENT BUREAU, SAPPORO

Dr. Hiroshi Kubo
Chief Pavement Laboratory
Civil Engineering Research Institute

Mr. Kazuyuki Kawamura
Researcher, C.E.R.I.

7. HOKKAIDO UNIVERSITY, SAPPORO

Dr. Teruo Sugawara
Professor, Faculty of Technology

Dr. Akihiro Moriyoshi
Ass't Prof.- Civil Engineering

Dr. Terutoshi Kaku
Professor, Civil Engineering

8. CITY OF SAPPORO

Mr. Iwao Sato
Sub-Chief, Business Admin. Section
Dept. of Public Works

9. KANAZAWA UNIVERSITY, KANAZAWA

Dr. Saburo Matsuno
Professor, Faculty of Technology

APPENDIX "C"

Information Package - Contributed by Canada

A. STUDDED TIRES

- "Fffect of Studded Tires on the Durability of Road Surfacing", J. Hode Keyser, Highway Research Record 331, 1970.
- "Resistance of Various Types of Bituminous Concrete and Cement Concrete to Wear by Studded Tires", J. Hode Keyser, Highway Research Record 352, 1971.
- "Mix Design Criteria for Wear-Resistant Bituminous Pavement Surfaces", J. Hode Keyser, Highway Research Record 418, 1972.
- "Pavement Wear Due to Studded Tires and the Economic Consequences in Ontario", P. Smity and R. Schonfeld, Ontario Research Report 152, Jan. 1970.
- "Studies of Studded-Tire Damage and Performance in Ontario - Winter 1969-70", P. Smith and R. Schonfeld, Ontario Research Report 165, Aug. 1970.
- "An Evaluation of Surface Course Mixes Designed to Resist Studded Tire Wear", H.J. Fromm and J.T. Corkill, Ontario Research Report 171, Feb. 1971.
- "Thoughts on Tolerable Pavement Wear", P. Smith and R. Schonfeld, Ontario Research Report 179, May 1972.
- "Winter Accident Experience in Ontario With and Without Studded Tires", P. Smith, Ontario Research Report 183, Nov. 1972.
- "Carbon Black Reinforcement of Asphalts in Paving Mixtures", B.A. Vallerga and P.F. Gridley, ASTM Symposium "What's New in Asphalt Paving?", San Diego, California, Dec. 12, 1979.
- "Resistance to Wear of Different Bituminous Mixtures for Surface Courses", Kohler and Tappert, AAPT 1972.
- Listing of literature on Studded Tire Wear.

B. FROST HEAVING

- Extracts from MTC Soils Manual
- "Frost Penetration in Highways: The Role of Heat Stored in the Subgrade", P.J. Williams, Ontario Research Report 1R58, March 1976.
- "Frost Penetration in Ontario Highways", R. Chisholm and W.A. Phang, RTAC 1978.
- "The Val Gagne Pavement Insulation Experiment", T. Louie, R. Chisholm and W.A. Phang, RTAC 1979.
- "Frost Action in Soils, State-of-the-Art", J.P.G. Loch, 2nd Int. Symposim on Ground Freezing, Norway, June 1980.
- "The Influence of Mineral Composition on Frost Susceptibility of Soils", B. Heinz, 2nd Int. Symposium on Ground Freezing, Norway, 1980.
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- "Temperature - Susceptibility Control in Asphalt Cement Specifications", H.J. Fromm and W.A. Phang, Ontario Research Report 1R35, Nov. 1970.
- "A Study of Transverse Cracking of Bituminous Pavements", H.J. Fromm and W.A. Phang, Ontario Research Report 176, Jan. 1972.
- "Notes on Transverse Cracking of Asphalt Pavements", W.A. Phang, Sept. 1968.
- "Thermal Shrinkage Cracking of Some Ontario Pavements", R.C.G. Haas, Ontario Research Report 161, May 1969.
- RTAC Symposium on Frost Action, Sept. 1957.

C. DRAINAGE

- "Improving Pavement Drainage using Perforated Plastic Pipe Subdrains", J.B. MacMaster, Ontario Engineering Materials Office, Report 17.
- "The Geotechnical Use of Filter Fabrics in Highway Construction", A.K. Barsvary and P. Korgemagi, Ontario Engineering Materials Office Report EM-13, Oct. 1979.

D. PAVEMENT CONDITION RATING AND USES

- "Manual for Condition Rating of Flexible Pavements - Distress Manifestations", G.J. Chong, W.A. Phang and G.A. Wrong, Ontario MTC, Aug. 1975.

- "Manual for Condition Rating of Rigid Pavements - Distress Manifestations", G.J. Chong, W.A. Phang and G.A. Wrong, Ontario MTC, Aug. 1977.

- "Pavement Condition Ratings and Rehabilitation Needs", W.A. Phang, Ontario Research Report, May 1980.

- "Pavement Condition and Performance Observations, Brampton Test Road", W.A. Phang and G.M. Stott, Ontario Research Report, Oct. 1980 (Draft).

- "Pavement Maintenance Guidelines: Distresses, Maintenance Alternatives, Performance Standards.

E. NEW DEVELOPMENTS

- "Sulphur-Asphalt Concrete, Three Ontario Test Roads", H.J. Fromm and Dr. G.J.A. Kennepohl, Ontario Research Report, Feb. 1979.

- "Task Force Report on Hot Mix Recycling of Asphalt Pavements", Ontario Research Report, April 1979.

APPENDIX "D"

Information Package - Contributed by Japan

English Language Synopses

1. "Experimental Studies on Airport Pavements by Static Loading Tests", by H. Suda, H. Moriguchi, K. Sato, T. Hoshida, H. Kawamoto, Y. Abe Report of the Port and Harbour Research Institute, Vol. 9, No 3, Sept. 1970.

2. "A Study on Aircraft Load Distribution through Bases to a Subgrade - Design Load of a Jumbo Jet", K. Sato, H. Suda. Report of the Port and Harbour Research Institute, Vol. 11, No. 3, Sept. 1972.

3. "Study on the Presumption of K. Valves on Multi-Layer Subbase Systems", H. Suda, K. Sato. Report of the PHRI, Vol. 11, No. 1, March 1972.

4. "Evaluation of Latent Hydraulic Materials as Base Courses of Airport Pavements", K. Sato, T. Fukute, M. Sato. Report of the PHRI, Vol. 16, No. 4, Dec. 1977.

5. "A Rheological Study on the Asphalt Concrete for Airport Pavements", T. Fukute, K. Sato, H. Shibuya. Report of the PHRI, Vol. 14, No. 3, Sept. 1976.

6. "Studies on the Stability of Grooves in Asphalt Pavements", K. Sato, T. Fukute, M. Sato.

7. "A Study on the Average Contact Pressure of Airplane Tires", H. Suda, K. Sato, Y. Abe. Report of the PHRI, Vol. 9, No. 2, June 1970.

8. "The Relation Between Field and Laboratory CBR Values of Sands", H. Suda, K. Sato, Transactions of JSCE, Vol. 4, 1972.

9. "Dynamic Response of Bituminous Mixture", A. Kasahara, T. Sugawara. Trans. JSCE, Vol. 5, 1973.

10. "Studies on the Dependencies of Viscosity of Asphalt Cement on Temperature and Rate of Shear. Proc. JSCE, No. 208, Dec. 1972.

11. "Strain at Failure of Bituminous Mixtures", T. Kamijima, A. Moriyoshi, T. Sugawara. Proc. JSCE 221, Feb. 1974.

12. "Rheology and Failure Behaviour of Bituminous Mixtures in Viscoelastic Zone", A. Moriyoshi, T. Sugawara. Proc. JSCE 279, Nov. 1978.

13. "Influence of Properties of Asphalt on the Mechanical Properties of Mixtures", T. Sugawara, A. Kasahara. Proc. JSCE 268, Dec. 1977.

14. "Stress Relaxation Modulus of Epoxy Asphalt Mixture", M. Mayama, T. Sugawara. Proc. JSCE 275, July 1978.

15. "Dynamic Property of Bituminous Mixture and its Application to Analysis of Pavement Structure", A. Kasahara, H. Okagawa, T. Sugawara. Proc. JSCE 254, Oct. 1976.

16. "Failure Envelope of Bituminous Mixtures in Viscoelastic Zone, A. Moriyoshi, T. Sugawara. Proc. JSCE 251, July 1976.

17. "Changes of Dynamic Properties of Bituminous Mixtures Under Repeated Loading", A. Kasahara, T. Sugawara. Proc. JSCE 235, March 1975.

18. "Fracture Strength of Bituminous Mixtures", A. Moriyoshi, T. Kamijima, T. Sugawara. Proc. JSCE 210, Feb. 1973.

19. "A Mechanical Response Concept of Bituminous Mixture", T. Sugawara. Proc. JSCE 207, Nov. 1972.

20. "Dynamic Response of Asphalt Cement and Asphalt Mixtures by Vibration Reasonance Methods", A. Kasahara, T. Kamijima, T. Sugawara. Proc. JSCE 208, Dec. 1972.

21. "Effects of Degree of Compaction on the Mechanical Properties of Bituminous Mixtures", N. Nitta, A. Kasahara, T. Sugawara. J. Japan Petroleum Inst., Vol. 23, No. 2, 1980.

22. "Mechanical Properties of Catalytic Semi-Blown Asphalt and its Mixture", T. Sugawara, A. Nakajima, A. Kasahara.

23. "Fundamental Research on the Behaviour of the Construction Joint of Asphalt Pavement", A. Moriyoshi, T. Horio, T. Sugawara.

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24. "Evaluation and Design of Overlay Thickness of Airport Asphalt Pavements by Dynaflect Deflections", K. Sato, T. Fukute. Transactions JSCE.

25. "Some New Construction Methods for Prestressed Concrete Airport Pavements", K. Sato, T. Fukute, H. Inukai. Prepared for presentation at Purdue University Conference, April 1981.

26. Diagrams illustrating the new experiments at the Bibi Test Road.

APPENDIX "D" (cont'd)

27. "Resistance of Modified Asphalt Mixtures to Freezing and Thawing Cycles", H. Kubo.

- "Pavement Design in Cold Areas", F. Kono, T. Takahashi, H. Kubo.

- "Bibi Test Road on Frost Action Influencing Asphaltic Pavements", F. Kono, T. Wakaboyashi, H. Kubo, H. Kanzaki.

CERI, Hokkaido Development Bureau, Oct. 1978.

28. "Frost Heave of Roads in Hokkaido and Its Countermeasures", M. Koyama, H. Sasaki, CERI, Hokkaido Development Bureau.

29. "Analytical Evaluations of Frost Heave Preventing Methods in Asphaltic Pavements", H. Kubo, T. Sugawara.

30. "Transverse Crackings of Asphaltic Pavements in Cold Regions", H. Kubo, T. Sugawara, A. Moriyoshi.

31. "Failure Behaviour of Bituminous Mixtures", T. Sugawara, A. Moriyoshi, H. Kasahara, J. Petroleum Inst., Vol. 17, No. 1, April 1975.

32. "Brittleness and Visco-Elasticity of Bituminous Mixtures", T. Sugawara. Annual Report of Roads, 1970, Japan Roads Association.

33. "Mechanical Response of Bituminous Mixture under Various Loading Conditions", T. Sugawara.

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34. "Production of Skid Testing Vehicle and Skidding Resistance of Variable Tread Patterns of Tires on Snow Covered Road Surface", T. Kaku, K. Horiuchi, Y. Onodera, June 1977.

35. "Traffic Accidents in Winter Related to Some Weather and Road Conditions", T. Kaku, June 1977.

36. "Traffic Flow in Winter", T. Kaku. Journal JSME, Sept. 1979.

37. "A Study on the Resistance of Snowplowing and the Running Stability of Snow Removal Truck", T. Kaku.

EXHIBIT 4

Index of PICA Workshop Proceedings

PICA I, Vancouver, Canada, 1982
PICA II, Tsukuba, Japan, 1984
PICA III, Ottawa, Canada, 1987

Paving in Cold Areas

Mini-Workshop

October 18-22, 1982

Vancouver, B.C.
Canada

REPORT DOCUMENTATION FORM

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17. Abstract

The joint Canada/Japan Paving in Cold Areas Mini Workshop held in Vancouver between October 18 - 22, 1982 brought together Canadian and Japanese experts in the areas of pavement research to discuss the particular problems of paving in cold areas. The workshop consisted of six sessions at which twenty-three papers were presented and one panel discussion took place. The six major topic areas covered in the workshop were: low temperature cracking, materials and construction to overcome freezing problems in soils, frost penetration and the prevention of frost heaving, the prevention and cure of reflection cracking, characteristics of paving materials, and additives in asphalts.

18. Key Words	19. Distribution Statement
Paving, frost heaving, low temperature cracking, asphalt additives, paving materials	Limited number of copies available from TDC

20. Security Classification (of this report)	21. Security Classification (of this page)	22. No. of Pages	23. Price
Nil	Nil		Nil

TDC 0317 (9-83)

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of PWRI No. 2136

PROCEEDINGS OF PAVING IN COLD AREAS MINI-WORKSHOP CANADA/JAPAN SCIENCE AND TECHNOLOGY CONSULTATIONS October, 1984

Pavement Division
Road Department
Chemistry Division
Geology and Chemistry Department
Public Works Research Institute
Ministry of Construction

MINISTRY OF TRANSPORTATION
AND COMMUNICATIONS
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Technical Memorandum
of PWRI No. 2136
Oct., 1984

PROCEEDINGS OF PAVING IN COLD AREAS MINI-WORKSHOP CANADA/JAPAN SCIENCE AND TECHNOLOGY CONSULTATIONS

by
Pavement Division
Chemistry Division

Synopsis:

This Technical Memorandum of PWRI is the proceedings of the second Mini-Workshop of "Paving in Cold Areas", which is one of the research subjects of Canada/Japan Science and Technology Consultations. These proceedings consist of 34 papers, 16 Canadian ones and 18 Japanese ones. The topics discussed at the Mini-Workshop are stated below.

Pavement Management
-Measurement of quality of service (the what and how)
-Automated data collection and analysis (the why and when)
-Criteria for quality of service for various classes of highway
-Timing and methods of preventive maintenance
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-Applications and effectiveness of asphalt additives such as polymers
-Various new techniques and materials
-Mix design and pavement structure design
-Theoretical analysis of reflection cracking
-Measurement of crack movement
-Timing and materials, methods and equipment for maintaining reflection cracking

Keywords:

Canada/Japan Science and Technology Consultations, Paving in Cold Areas, Reflection Cracking, Wearing, Maintenance and Repair, Fatigue Breaking, Cracking, Asphalt Pavement, Pavement Life, Evaluation of Performance, Rutting, Thermal Stress, Overlay, Concrete Pavement, Elastic Force, Improved Asphalt, Studded Tire, Freezing and Thawing Test

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Paving in Cold Areas

Volume 1

Mini Workshop 3

Canada/Japan Science and Technology Consultations

Ottawa, Ontario
July 20-22, 1987

Technical Report Documentation Page

Paving in Cold Areas

Proceedings of 3rd Canada/Japan Workshop (Vol. 1)

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Abstract:	These two volumes contain the Proceedings of the 3rd Canada/Japan workshop on Paving in Cold Areas. Papers are presented in English with abstracts in Japanese. The papers cover a broad range of topics within the subject areas. These include: • asphalt cements for low temperature cracking, • low temperature cracking, • treatment of transverse reflection cracking, • maintenance, • recycling, and • pavement management and research needs.
Comments:	The 3rd Canada/Japan workshop on Paving in Cold Areas was held in Ottawa, Ontario, July 20-22, 1987.
Key words:	pavements, cracking, maintenance, recycling, low temperature cracking, frost heaving, asphalt additives, paving materials
Distribution:	Each delegate to the conference received a copy of the Proceedings. A limited number of extra copies are available on request to the conference chairman, Mr Phang.
Copyright Status:	Persons wishing to reproduce portions of the proceedings should seek the permission of the individual authors.

FOREWORD

Paving in cold areas is once again the theme of this, the third Canada/Japan Workshop, an information exchange and collaborative activity confirmed under the Canada/Japan Agreement on Cooperation in Science and Technology, Tokyo, 7th May, 1986. The first workshop was held in Vancouver, B.C. in October, 1982, and the second was held in Tsukuba, Japan in October, 1984.

The PICA-3 Workshop was organized by a sub-committee of the Pavements Technical Committee, Roads and Transportation Association of Canada. The sub-committee was comprised as follows:

- W.A. Phang, Ontario Ministry of Transportation and Communications
- G.J.A. Kennepohl, Ontario Ministry of Transportation and Communications
- W.F. Johnson, Transport Canada
- B. Hicks, Roads and Transportation Association of Canada
- J. Emery, John Emery Geotechnical Engineering Ltd.
- R. Langlois, Québec Ministry of Transportation
- R.C.G. Haas, University of Waterloo, Ontario

The workshop principally covers topics dealing with asphalt cement for use in cold climates, low temperature cracking problems and their treatment, maintenance, recycling, pavement management, and new materials. More than 30 papers are contained in these *Proceedings*. The language of the workshop is English, but abstracts are provided in both English and Japanese.

Japanese participation was organized and coordinated by Mr. Yutaka Anzaki of the Public Works Research Institute, Japan Ministry of Construction, with the encouragement of Peter L. Eggleton of the Canadian Embassy in Tokyo.

Thanks are due to the Ontario Ministry of Transportation and Communications for their continued support, particularly the efforts of the Research and Development Branch editor and his staff. Transport Canada, and the Roads and Transportation Association of Canada played key roles, and contributions from the Québec Ministry of Transport, and from consultants and the construction industry are gratefully acknowledged.

William A. Phang
Chairman, Paving in Cold Areas Workshop 3

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EXHIBIT 5

Field Trip

PAVING IN COLD AREAS

(Field Trip)

Thursday, October 21, 1982 - Field Inspection of Chem-Crete Asphalt Mix Test Section near Keremeos.

Friday, October 22, 1982 - Field Inspection of Transverse Crack Suppression Test Sections near Kamloops.

Report Prepared by: J. F. Meidinger
Regional Manager, Paving
Kamloops

Report Presented by: B. C. Draper
Senior Project Supervisor
Kamloops

CHEM-CRETE TEST SECTION

1980

HIGHWAY 3 - BETWEEN HEDLEY AND KEREMEOS

(A) ABSTRACT

The construction of a test section using Chem-Crete Bitumen was carried out with the objective of comparing the properties of Chem-Crete Asphalt Mix and the properties of the Unmodified Asphalt Mix under field conditions.

Approximately 6 tonnes of Chem-Crete Bitumen was shipped from San Francisco and blended into the Asphalt Cement in the contractor's tanks at a ratio of one part Chem-Crete Bitumen to 9 parts Asphalt Cement. Approximately 1085 tonnes of Chem-Crete Asphalt Mix was placed in two 37 mm lifts covering a total length of 1.14 lane kilometres.

Subsequent testing and observations of the field performance indicate that the Chem-Crete Asphalt Mix exhibits accelerated age harding compared to the unmodified mix and severe cracking and disintegration began taking place within the first year of service.

(B) INTRODUCTION

The Chem-Crete Corporation approached the B. C. Ministry of Transportation and Highways concerning the use of their Chem-Crete Bitumen in asphalt concrete mixes. The bitumen was purportedly a product of a new refining technique that improved all the key properties of the asphalt such as stability, strength, durability, temperature susceptibility, fatique life and water resistance. These improvements would also effect a reduction in initial cost because the pavement thickness could be reduced by as much as 40%.

The Ministry decided to construct two (2) test sections using the Chem-Crete Bitumen, one section in the southern interior part of the province where the summer temperatures are very high and the other section in the northern interior where the winter temperatures are very cold.

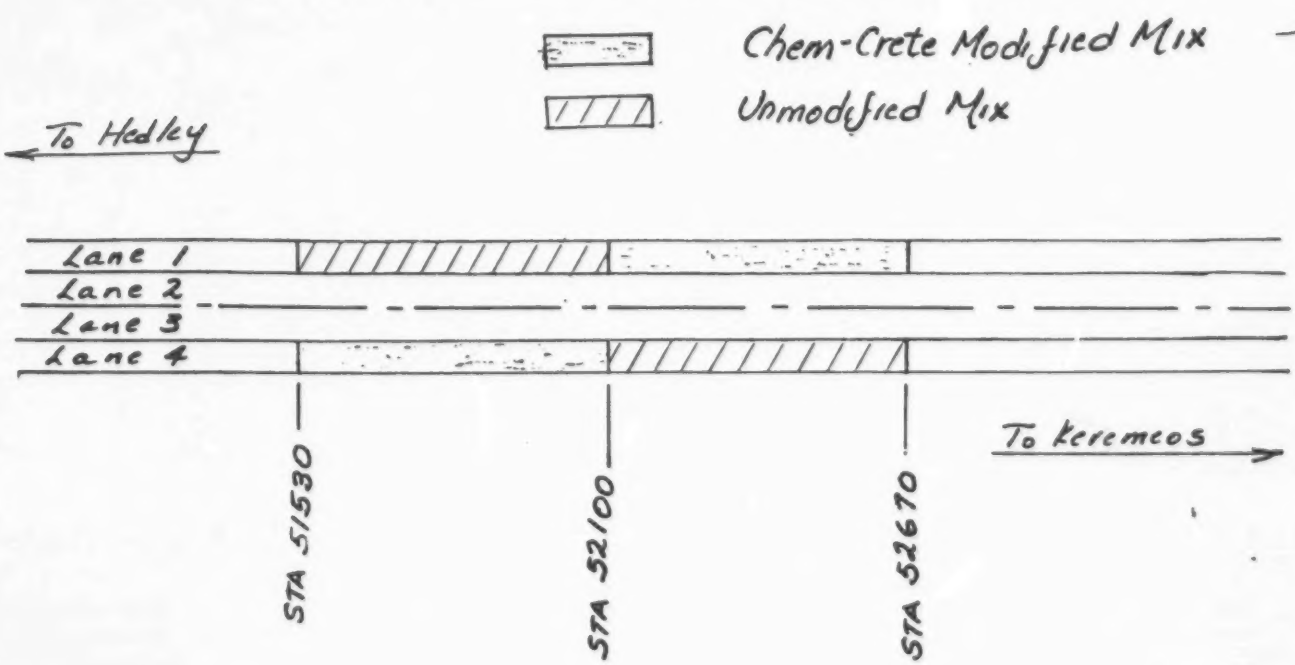
This report is on the construction of a test section near Keremeos, B. C. in the hot southern interior of the province.

(C) TEST SECTION LOCATION AND DESCRIPTION

The section of B. C. Highway No. 3 being paved under the Ministry's Project S-792402 extended from 6.3 Km west of Hedley to Keremeos.

The specific test section constructed using Chem-Crete Modified Mix was a 1.14 km section of a 4-lane roadway some 13.6 km east of Hedley.

The test section was laid out as depicted in Figure 1.



1. Lanes 2 and 3 were an existing 2-lane paved roadway.
2. Lanes 1 and 4 were newly constructed lanes using a conventional gravel base.
3. All 4 lanes were paved in two equal lifts for a total thickness of 75 mm.

(D) MIX DESIGN AND PRELIMINARY WORK

The Ministry was advised by Chem-Crete Corporation not to change the design procedure for Chem-Crete Modified Mix. As a consequence, the following design was used for both the modified and unmodified mix:

DESIGN GRADATION

Sieve Size	% by mass passing
16.0 mm	100.0
13.2 mm	88.7
9.5 mm	75.4
4.75 mm	56.0
2.36 mm	46.6
1.18 mm	40.7
0.600 mm	29.6
0.300 mm	15.0
0.150 mm	7.8
0.075 mm	5.1

MIX DESIGN

Mixing Temperature	139 (137-142)°C
Compaction Temperature	128 (126-131)°C
Asphalt Content, percent	5.7
Bulk Relative Density, specimen	2.374
Bulk Relative Density, aggregate	2.677
Air Voids, percent	4.7
V.M.A., percent	16.1
V.M.A. filled, percent	70.3
Marshall Load, newtons	5902
Marshall Flow, hundredth of inch	6.8
Index of Retained Marshall stability, percent	88.6
Asphalt Absorption, percent	0.617

Prior to any field work a sample of IOCO AC-8 modified with 10% Chem-Crete Bitumen was received for preliminary work.

The main findings were:

1. Modified Binder

   - % retained penetration after TFOT was low indicating a fast hardening product.
   - temperature susceptibility was unchanged.
   - slightly lower ductility.
   - recovered asphalt from briquettes allowed to cure for 28 days at 45°C was very hard.

2. Modified Mix

   - stability of specimens allowed to cure for 28 days at 45°C was 70% higher.
   - slightly higher flow index.
   - Retained Marshall Stability remained unchanged.

(E) TEST SECTION CONSTRUCTION

The Chem-Crete binder delivered by tanker truck from San Francisco on June 10, 1980. Approximately 6.16 tonnes was pumped off for this test section and the other 11.49 tonnes continued on to Fort St. John, the site of the second test section. The Chem-Crete modified asphalt was made by mixing one part Chem-Crete Bitumen to nine parts Imperial AC-8.

All mix was produced in a Barber Greene, Model 65A, Thermogard 100 TPH drum mixer; layout by a Cedar Rapids paver on bottom lift and a Barber Greene SA-145 on top lift, and compacted with a Hyster single drum vibratory roller and a Hyster rubber-tired roller (9 tires).

The bottom lift of the test section was constructed on June 11, 1980 under ideal weather conditions. There were 441 tonnes of modified mix placed that day in the test section.

The top lift of the test section was constructed June 23, 1980 under ideal weather conditions. There were 644 tonnes of modified mix placed in the test section that day.

All quality control tests and measurements indicated a consistent mix produced very close to the design requirements.

(F) MODIFIED MIX ANALYSIS

During the construction 24 asphalt samples were gathered for testing. The results are contained in Table 1.

During the construction 22 compacted specimens were prepared and the results are contained in Table 2.

During the construction 38 cores were drilled and the results are contained in Table 3.

Some of the more important observations and test results were as follows:

1. Freshly laid Chem-Crete mix has 7.5% lower stability than the unmodified mix. It also has a 5.5% lower Marshall Flow Index.

2. After 28 days of curing at 60°C in air bath, the unmodified mix gained only 20.6% Stability while the Chem-Crete modified mix gained 88.7% Stability. There is a 33.8% increase in Flow Index by curing Chem-Crete mix.

3. Unmodified AC-8 (control section) asphalt after 28 days of curing at 60°C in air-bath still has a penetration of 37-42 at 25°C. AC in the pavement will arrive to this stage in about 6 - 10 years.

4. Chem-Crete modified asphalt after 28 days of curing at 60°C in air bath has a low penetration of 19 - 21 at 25°C. A pavement with unmodified AC would break up at this low penetration stage.

5. Binder in the freshly laid Chem-Crete section has the same degree of hardness (aging) as unmodified binder after 8 - 12 years of road servie.

6. There is no difference in the critical temperature (Tc) between modified and unmodified products.

7. The Ductility of Chem-Crete Modified Asphalt drops drastically (from +145 to 21 and 27) after 28 days of curing at 60°C.

(G) STRUCTURAL CAPACITY ANALYSIS

Testing of the surface rebound was done with a Benkelman Beam on the gravel prior to paving; on the pavement immediately after completion; and four times since on July 15, 1980, October 28, 1980, April 30, 1981, and September 8, 1981.

The primary conclusion as a result of this testing is that Chem-Crete modified mix has no affect on the surface rebound of the roadway.

(H) POST CONSTRUCTION FIELD OBSERVATIONS

Cracking, extreme wear and some disintegration were evident by January, 1981, only seven months after the test section was constructed.

The Chem-Crete modified mix looked like it had aged (hardened) prematurely resulting in random cracking, wear, and ravelling.

The surface continues to deteriorate at a much more rapid rate than the unmodified mix.

(I) REFERENCES

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2. B. Varady "Final Report on Chem-Crete Test Section, Keremeos", 1980.

3. J. D. Mewhort "Preliminary Report on Test Sections - Paving Project 2402 - Chem-Crete", 1980.

S-792402, KEREMEOS TEST SECTION

TABLE OF BINDER TEST REPORT

Control Section, AC-8 Ioco, Unmodified

Bottom Lift

	VISCOSITY @135°C	VISCOSITY @60°C	PENETRATION @25°C	PENETRATION @15.6°C	PENETRATION @10°C	Tc	% RETAINED PENETRATION @25°C	DUCTILITY @25°C
Original AC	216	817	82	22	10.5		100.0	+145
After TFOT	299	1626	52	18	9.0	-25	63.4	+145
After just laid	292	1544	58	19	10.0	-27	70.7	+145
After 28 days curing @60°C air bath	393	3069	37	15	8.0	-28	45.1	+145

Top Lift

Original AC	212	726	83	24	12.0		100.0	+145
After TFOT	273	1427	53	17	9.5	-27	63.9	+145
After just laid	237	1313	65	21	11.0	-28	78.3	+145
After 28 days curing @60°C air bath	343	2622	42	16	9.0	-29	50.6	+145

Chem-Crete, Modified AC-8

Bottom Lift

Original AC	195	560	105	28	13.0		100.0	+145
After TFOT	290	1686	56	19	10.0	-28	53.3	+145
After just laid	369	3575	38	15	8.5	-29	36.2	+145
After 28 days curing @60°C air bath	613	13256	21	10	6.0	-30	20.0	27

Top Lift

Original AC	189	512	120	32	14.0		100.0	+145
After TFOT	301	1658	56	19	10.0	-28	46.7	+145
After just laid	510	7628	32	12	8.0	-30	23.3	+145
After 28 days curing @60°C air bath	720	20069	19	9	5.5	-29	15.8	21

NOTE: 1. "After just laid" results are on recovered binder from fresh pavement.

2. "After 28 days curing" results are on binder recovered from briquettes after 28 days of curing.

TABLE I

S-792402, KEREMEOS TEST SECTION

TABLE OF PLANT BRIQUETTES

	Control Section		Chem-Crete Section	
	Bottom Lift	Top Lift	Bottom Lift	Top Lift
A. Standard Procedure				
Relative Density	2.420	2.425	2.424	2.423
Marshall Stability, N	7311	7040	6648	6614
Marshall Flow, 1/100"	8.1	8.2	8.0	7.4
B. After 28 Days Curing @ 60°C Air Bath				
Relative Density	2.421	2.426	2.426	2.425
Marshall Stability, N	8388	8917	11912	13116
Marshall Flow, 1/100"	7.2	8.3	10.2	10.4

Note: 1. Each result shown above represents the average of 3 specimens, each of them were made at a different time.

2. Plant briquettes for bottom lift were made on the 13th of June, 1980 for top lift on the 23rd of June, 1980.

TABLE 2

S-792402, KEREMEOS TEST SECTION

TABLE OF ROAD CORES

	Depth of Pavement	Relative Density	Degree of Compaction	% Road Density
CONTROL SECTION				
Bottom Lift	1.5"	2.309	95.4	96.7
Top Lift	2.0"	2.313	95.4	96.9
CHEM-CRETE SECTION				
Bottom Lift	1.6"	2.345	96.7	98.2
Top Lift	2.0"	2.314	95.5	96.9

Note: 18 cores were drilled on the top lift and 20 cores on the bottom lift of pavement for Density and Recovery purposes.

TABLE 3

TRANSVERSE CRACK SUPPRESSION TEST SECTIONS

HIGHWAY 97 - VICINITY OF MONTE LAKE

(A) ABSTRACT

In-place cold mix recycling and placement of reinforcing geotextile fabric were carried out with the objective of reducing or prohibiting reflective transverse cracking in the new pavement.

The in-place cold recycling was performed on grindings from a milling machine by adding Cyclogen ME rejuvenating agent, HF500(M) high float mixing grade emulsion, and HF500(M) plus 40% new aggregate in three test sections. The two HF500(M) recycling sections were judged to be the best quality recycled asphalt base course on which to place the hot mix recap.

Both the woven polyprophylene and non-woven polyester types of geotextile from three manufacturers were used. The non-woven polyester was judged to be the easiest fabric to install because it had less tendency to wrinkle.

The success, if any, of all the test sections in reducing reflective cracking is yet to be ascertained and will be the subject of further monitoring and future appendices to this report.

(B) INTRODUCTION

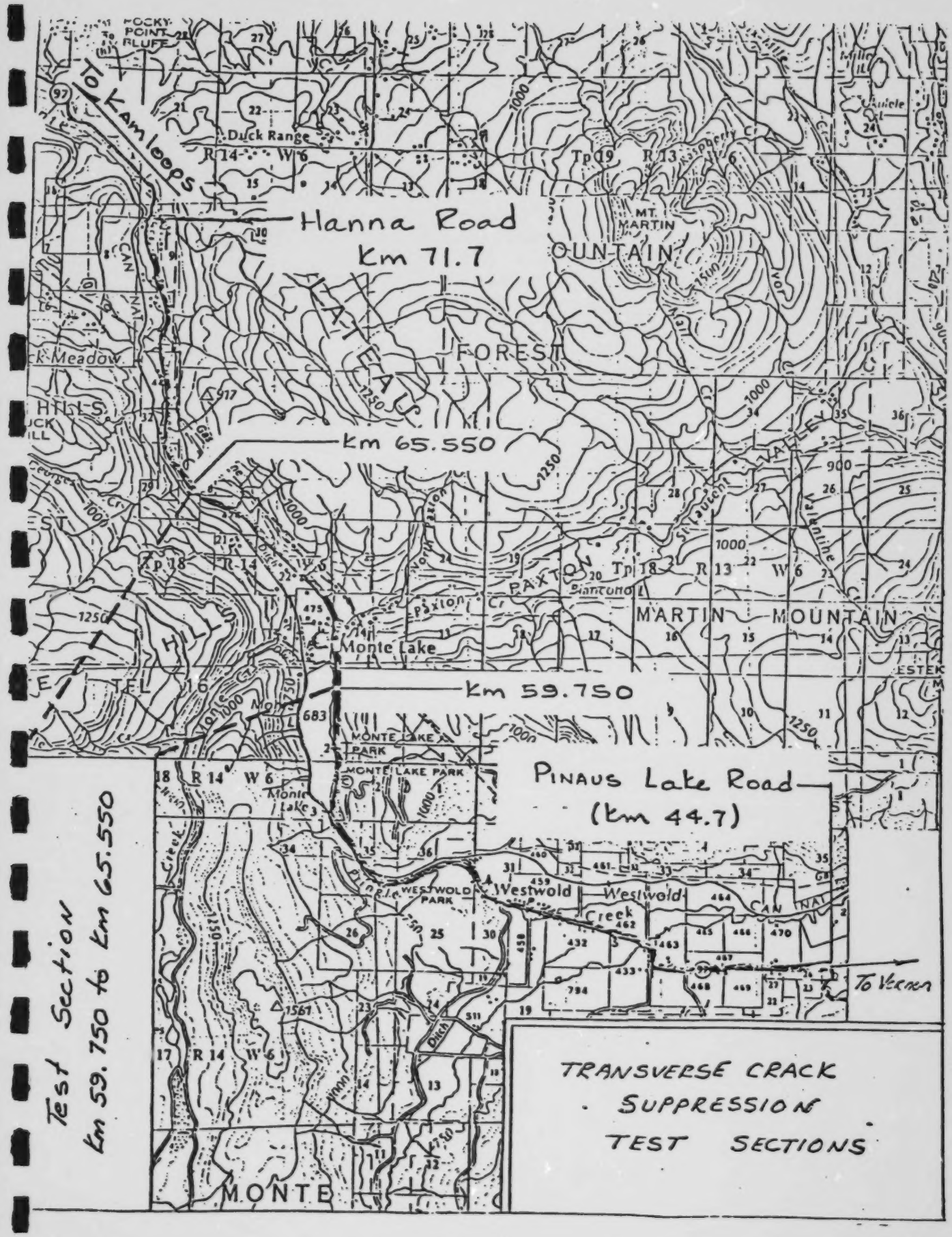
A section of the Vernon-Kamloops Highway 97 which had been previously paved in 1970 had deteriorated to a point in 1980 that an asphalt concrete overlay was planned and tendered for the summer of 1981 under the Ministry's Contract S-0645.

The specific section involved was from Pinaus Lake Road at Km 44.7 to Hanna Road at Km 71.7 (27 km). (See Figure 1).

There were future plans to reconstruct the said section within the next 10 years so the Ministry decided to repave the roadway with a single 50 mm lift of asphalt pavement now to maintain the surface in an acceptable condition for the 10 year period.

The existing 1970 pavement which had been chip sealed in 1971 was characterized by numerous close interval transverse temperature cracks which had begun to spall at the crack in the wheelpaths. The patching on this section of highway had reached an unacceptably high level by about 1979.

It was recognized that with the planned thin overlay (50 mm) on such a badly cracked roadway, reflection cracking in the new overlay would be a certainty and would therefore afford the Ministry an excellent opportunity to field test different techniques that purportedly suppressed the reflection of the transverse temperature cracks in the underlaying asphalt through into the new asphalt mat.


Hanna Road
Km 71.7
Km 65.550
Km 59.750
Pinaus Lake Road
(km 44.7)
Test Section
Km 59.750 to Km 65.550
TRANSVERSE CRACK
SUPPRESSION
TEST SECTIONS
Monte Lake
Westwold
Duck Range
MT. MARTIN
MARTIN MOUNTAIN
PAXTON
FOREST
MONTE
To Vernon

(C) TEST SECTION DESCRIPTION AND LOCATION

The section chosen for all the crack suppression test sections was a 5.8 km section of Highway 97 that started about 1 km south of the Village of Monte Lake and went northerly for approximately 4.8 km. The individual sections are described as follows:

Section A - Reinforcing Fabric Test Section

Km 59.750 to Km 62.55 (2.8 km)

Section B - In-place Cold Recycle Test Section

Km 62.950 to Km 63.790 (0.84 km)

Section C - Control Section with No Suppression Technique

Km 63.790 to KM 65.550 (1.76 km)

*Km 61.00 - intersection of Paxton Valley Road and Highway 97 in the Village of Monte Creek.

The test sections are not of equal length nor are they continuous because the test section lengths had to be changed due to availability of necessary materials.

See Figure 2 for key plan showing location of test sections.

The section was chosen as it was considered average in transverse crack frequency and average in severity of crack disintegration and the topography lent itself to low level flying which was done to photo record the existing cracks.

(D) TEST SECTION PREPARATION

1. Photo Record

The whole length of the test section from Km 59.750 to Km 65.550 was flown in the spring of 1981 to photo record the transverse cracks in the existing pavement to be overlayed. The section will be flown each year after to photo record the resurgence of the reflective cracking as it occurs.

2. Crack Filling

Test Sections A and C received a crack filling treatment.

Originally all cracks were going to be filled with a HF150(S) emulsion asphalt and blinded with a sharp fine sand. A hand sprayer on a distributor truck was used to spray the HF150(S). Problems occurred almost immediately with HF150(S) breaking in the distributor and

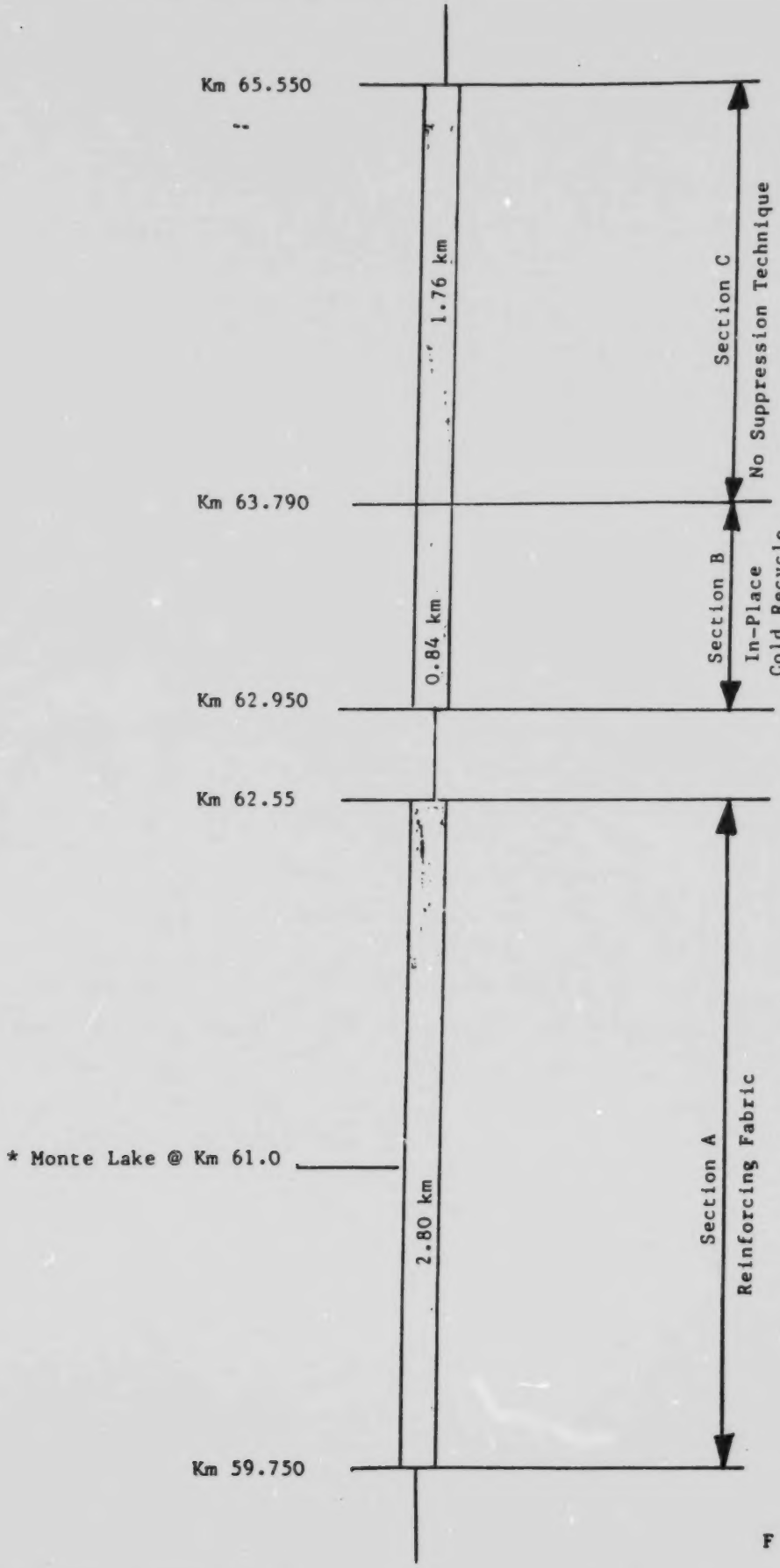

Km 65.550
1.76 km
Section C
No Suppression Technique
Km 63.790
0.84 km
Section B
In-Place
Cold Recycle
Km 62.950
Km 62.55
* Monte Lake @ Km 61.0
2.80 km
Section A
Reinforcing Fabric
Km 59.750

FIGURE 2

spraying equipment so only about ½ the cracks got filled with HF150(S). Of the ones that were filled, many had the asphalt picked out by vehicle tires before paving occurred.

As a consequence all cracks including cracks that had been filled with HF150(S) were filled with fine asphalt mix by hand placing methods prior to paving. The fine mix was compacted with a small roller.

3. Crack Counts

In addition to the photo log, all cracks were referenced by mathematical station, classified by type and counted in number.

The following table summarizes the number of cracks by type.

SPRING 1981 TRANSVERSE THERMAL

CRACK COUNTS

Type 1 - Transverse Crack 0.6 m < Length < 3.0 m

Type 2 - Transverse Crack Length > 3.0 m

SECTION	STA to STA	NUMBER			FREQUENCY (No./km)		
		Type 1	Type 2	Total	Type 1	Type 2	Total
Fabric Test Section A	59.750 to 62.550 (2.8 km)	43	301	344	15	108	123
Cold Mix Recycle Section B	62.950 to 63.790 (0.84 km)	9	57	66	11	68	79
Control Section C	63.790 to 65.550 (1.76 km)	12	126	138	7	72	78
Average	5.4 km			548			101

(E) TEST SECTION A - REINFORCING FABRIC TEST SECTION

Because the Ministry had no experience with installing geotextiles, some experimenting with metre square test patches prior to the main installation was carried out to ascertain the best bonding agent and at what application rate. Asphalt emulsion RS-2k at an application rate of 0.75 ℓ/m^2 was chosen.

The fabrics were placed as depicted in Figure 3 using a shop made fabric laydown machine from July 13 to 16, 1981.

The following summary comments are made about each of the four (4) fabrics installed:

1. Synflex Permaliner 2006 (Woven)

   - this was the strongest of the fabrics used.
   - there was some wrinkling and buckling of fabric during placement especially on curves.
   - the asphalt mix tended to check and crack immediately behind the screed and during compaction probably because the fabric is very smooth.

2. Synflex Permaliner 4545 (Non-woven)

   - there was some wrinkling of fabric especially on curves.
   - there was no problem with checking and cracking of the asphalt mat.

3. Du Pont "Reepav" (Non-woven)

   - only 100 yards of this fabric laid.
   - the asphalt mix checked and cracked when rolled.
   - texture is like a thin cardboard.
   - not enough installed to make and firm conclusions.

4. Crown Zellerbach "Petromat" (Non-woven)

   - only 215 yards of this fabric laid.
   - very similar in appearance and texture to Synflex Permaliner 4545.
   - lower in strength than Synflex 4545.
   - least wrinkling of all fabrics.
   - very little wrinkling on tangent or curve.

(F) TEST SECTION B - COLD RECYCLE TEST SECTION

1. Test Section Layout

The in-place cold recycle was done using three (3) different methods. The roadway was milled with a grinding machine full width (7.3 m) to a depth of 50 mm and the cuttings were windrowed on one shoulder of the road. The windrowed cuttings were reprocessed as follows:

(a) Section No. B-1 (Km 62.95 to Km 63.070) - 120 metres

Using Cyclogen ME which is an emulsified rejuvenating agent. The supplier was Witco Chemical Canada Ltd. at a cost of

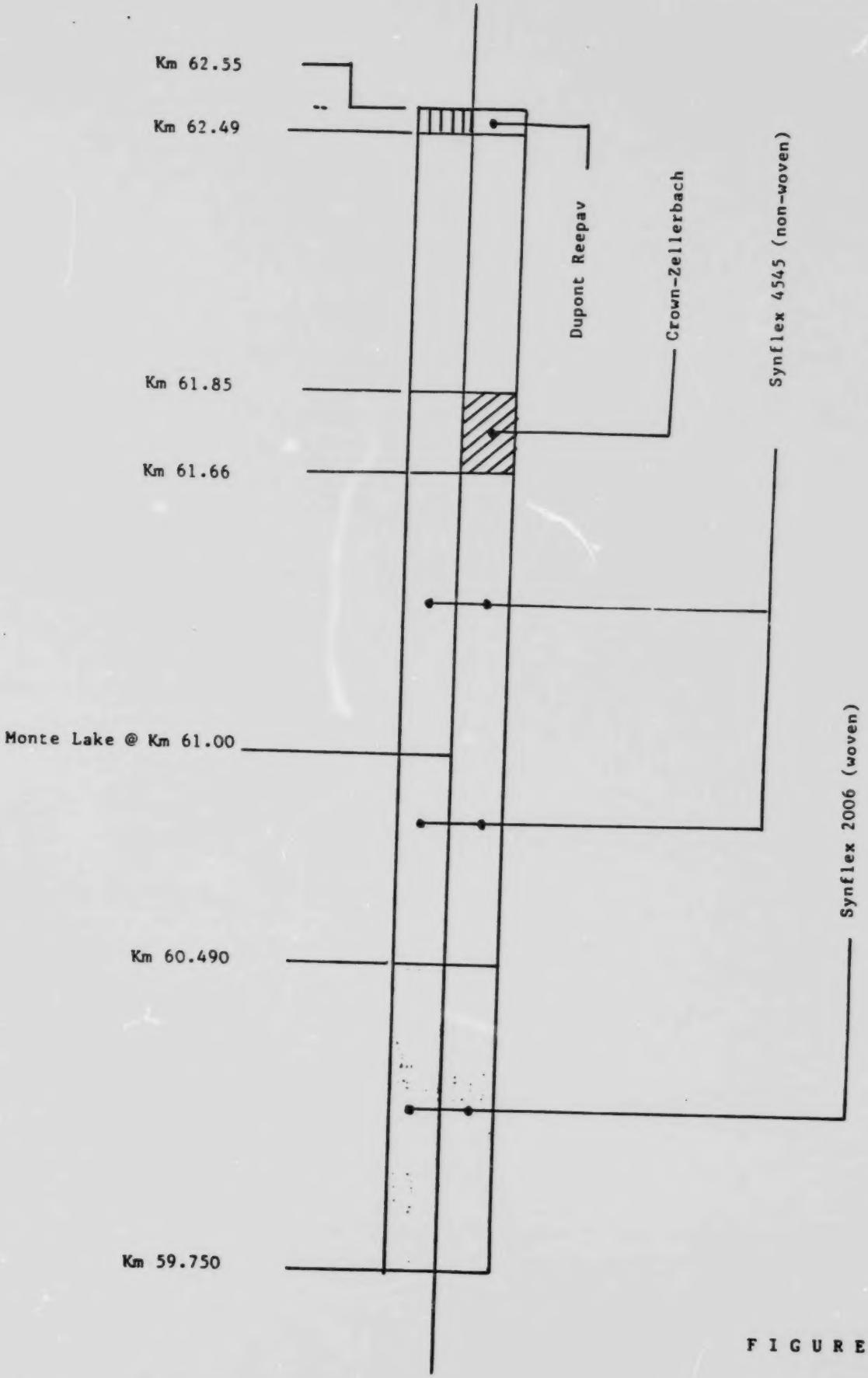

Km 62.55
Km 62.49
Dupont Reepav
Crown-Zellerbach
Synflex 4545 (non-woven)
Km 61.85
Km 61.66
Monte Lake @ Km 61.00
Synflex 2006 (woven)
Km 60.490
Km 59.750

FIGURE 3

$1.14/litre (1981 dollars) f.o.b. job site. This was shipped in 200 litre containers.

The length of Section No. B-1 is only 120 metres which is considered to be too short to be of great value but this length was fixed as we had only ordered 2200 litres of Cyclogen and this 2200 litres would only cover approximately 120 metres at the design application rate.

(b) Section No. B-2 (Km 63.070 to Km 63.450) - 380 metres

Using HF 500 (M) which is a high float emulsified mixing grade emulsion asphalt at a cost of $0.2296/litre (1981 dollars) f.o.b. job site. This material was supplied by Pounder Emulsions Group from their plant in Kamloops and delivered to the job site by tank truck.

(c) Section No. B-3 (Km 63.450 to Km 63.790) - 340 metres

Using the HF 500 (M) as in Section No. B-2 but adding 40% new aggregate to the recycle windrow.

The length of Sections No. B-2 and B-3 were set at approximately 300 metres as it was felt that 300 metres was a minimum length to evaluate results properly and there was a real desire to minimize the length of the recycle because of the possible negative consequences of a stability failure on Highway 97 in July with a summer traffic volume of 4300 ADT (1980 count).

See Figure 4 for a key plan showing the location of the three cold recycle test sections.

2. In-Place Recycle Construction

The major objectives that were set for the in-place recycled mix were:

(a) Ability to resist plastic deformation (rutting) under imposed loading throughout its design life.

(b) To remain intact under all weather and traffic conditions from the time of final compaction to overlay by hot mix,

and these objectives were to be met at the lowest possible rejuvenator content hence the lowest cost possible.

The quantities actually applied are as follows:

(a) Cyclogen ME

Design 2103 litres (2.5%)
Applied July 1, 1981 = 2150 litres
Applied July 2, 1981 = nil
Total = 2150 litres

Applied Percentage = 2.6% by weight of cuttings

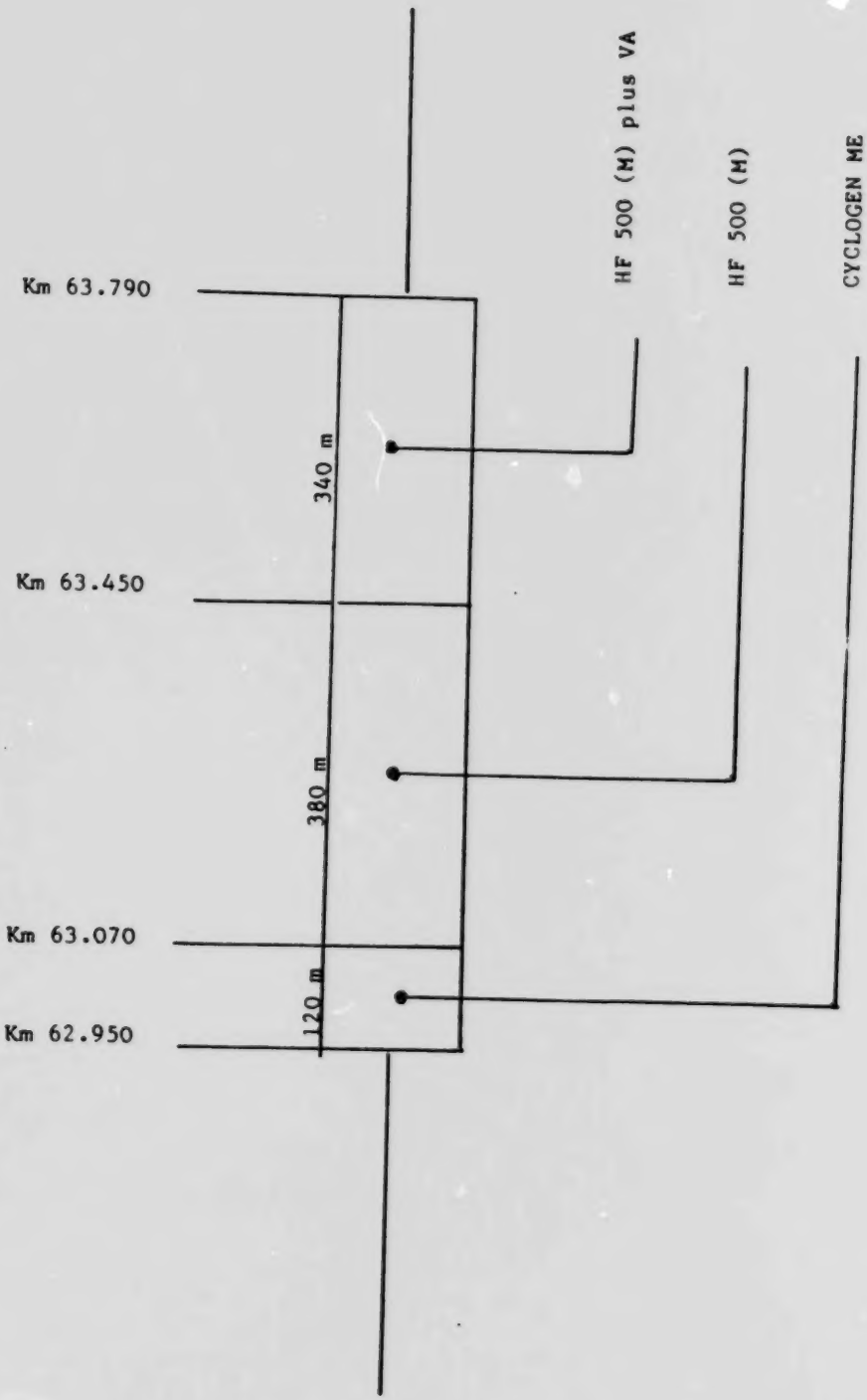

HF 500 (M) plus VA
HF 500 (M)
CYCLOGEN ME
Km 63.790
340 m
Km 63.450
380 m
Km 63.070
120 m
Km 62.950

FIGURE 4

(b) HF 500 (M)

Design 7656 litres (2.3%)
Applied July 1, 1981 = 5945 litres
Applied July 2, 1981 = 741 litres
Total = 6686 litres

Applied Percentage = 2.0% by weight of cuttings.

(c) HF 500(M)/VA

Design 13991 litres (3.8%)
Applied July 1, 1981 = 5320 litres
Applied July 2, 1981 = 663 litres
= 870 litres
Total 6853 litres

Applied Percentage = 1.9% by weight of cuttings plus virgin aggregate.

More HF 500(M) was not added even though the design percentage had not been achieved because it was felt that the recycled mix met all the objectives as set out above and adding more rejuvenator (HF 500(M)) would simply increase the cost with little or no improvement in quality.

The cold recycled mix obtained in all three sections met the objectives namely:

They did not deform plastically under imposed loading and they remained in tact until top lift hot mix recap was placed on July 13, 1981 and it did this at the lowest rejuvenator content which was deemed feasible.

(G) TEST SECTION OBSERVATIONS

Transverse Crack Counts done in spring 1982 are as follows:

Section A - Fabric

Synflex 2006 - 62.6% of cracks returned.

Synflex 4545 - 72.5% of cracks returned.

Section B - Recycle

Whole Section - 28.8% of cracks returned.

Section C - Control Section

Whole Section - 91.3% of cracks returned.

(H) REFERENCES

1. J. F. Meidinger "Transverse Crack Suppression Test Sections - 1981 - Highway 97 in Vicinity of Monte Lake", 1982.

EXHIBIT 6

Program and List of
Japanese and Canadian Participants

The Japan Road Contractors Association Seminar

The Prince of Wales Hotel, Niagara-on-the Lake, Ontario

Hampton Court Room, 8:30 a.m., July 7th, 1986

Sponsors: Ontario Road Builders Association
Ontario Ministry of Transportation and Communications
Roads and Transportation Association of Canada
Pavement Management Systems Ltd.
John Emery Geotechnical Engineering Ltd.

Supporting Agencies: Ontario Hot-Mix Producers Association

Seminar Organization: Ontario Ministry of Transportation and Communications

- Research and Development Branch
- Transportation Industry Office

PROGRAM

The Japan Road Contractors Association Seminar

The Prince of Wales Hotel, Niagara-on-the-Lake, Ontario

Hampton Court Room, 8:30 a.m., July 7th, 1986

8:30 a.m.	Welcome	Chuck E. Lawrence, President, ORBA
8:35	Introductions and Program Outline	Bill Phang, MTC
8:40	Purpose of JRCA Overseas Mission Survey	Tadao Watanabe ~~Takeshi Fujiwara~~, ~~Vice-President~~, JRCA
8:50	Roadbuilding in Ontario, Status and Future Recycling	Joe Gurowka, ORBA
9:10	The MTC Contract Tendering System and Some Aspects of Contract Administration	Don Thrasher, MTC
9:30	An Example of Concrete Paving to Current MTC Specs.	Paul Ostrander, ORBA
10:00	Coffee	
10:15	How to Manage a Model Paving Job	Earl KEE, OHMPA Red-D-Mix Conc. Co. (Asphalt Division)
10:45	Status & Future - Quality Control) - Recycling)	Dan Lynch, MTC
11:30	- Other Technology Development	John Emery, JEGEL
11:55	Announcements for the Afternoon's Program	Don Godfrey, MTC
12:00 noon	Lunch, 'Royals', Prince of Wales Hotel	
2:00 p.m.	Leave for tour of Inniskillin Winery	Coach, JRCA
3:30	Leave for Niagara Falls - "Maid of the Mist" Tour	
7:00	Dinner at Victoria Park Restaurant, Niagara Falls	John Robinson, RTAC
9-9:30	Return to Niagara-on-the-Lake	

LADIES PROGRAM

Prince of Wales Hotel, Niagara-on-the-Lake

9:00 a.m. July 7th, 1986

9:00 a.m.	Introduction, Coffee	Junette Douglin, MTC
9:30	Walkabout	
12:00 noon	Lunch	
2:00 p.m.	Visit Inniskillin Winery	Coach, JRCA
3:30	Visit Niagara Falls - 'Maid-of-the-Mist'	
7:00	Dinner at Victoria Park Hotel	
9-9:30	Return to Niagara-on-the-Lake	

THE JAPAN ROAD CONTRACTORS ASSOCIATION
SHIN-TOKYO BUILDING
3-3-1 MARUNOUCHI, CHIYODA-KU,
TOKYO, JAPAN
TEL (211) 8876-8

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Shoji	HASHIMOTO	President KAJIMA ROAD CO., LTD.
Tadao	WATANABE	President WATANABE-GUMI CO.,LTD.
Jitsuji	MORI	President OHBAYASHI ROAD CO., LTD.
Sanji	OGASAWARA	President TOBISHIMA ROAD CO., LTD.
Yoichi	TSUJI	Managing Director, TAISEI ROAD CONSTRUCTION CO., LTD.
Kikuo	TSUBAKI	Managing Director TOA DORO KOGYO CO., LTD.
Michio	ARAI	Managing Director NIPPON ROAD CO., LTD.
Fujimaru	TAKAHASHI	Director NIPPON HODO CO., LTD.
Hiroshi	HARABE	Director of Engineering Department MAEDA ROAD CO., LTD.
Shogo	MIYAMOTO	Managing Director KATSUYAMA ROAD CONSTRUCTION CO., LTD.
Kazuo	TAKADA	Director, Manager of Sapporo Branch SEIKITOKYU KOGYO CONSTRUCTION CO., LTD.
Toshimichi	AKASHI	The head of Nagano sales office KOKUDO ROAD CO., LTD.

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Nobuhiko	KINOSHITA	Director, Director of General Affairs Department. KINOSHITA KOGYO CO., LTD.
Satoru	OTSUKA	Manager of Nagoya Branch KUMAGAI ROAD CO., LTD.
Hitoshi	NAKATA	Managing Director DORO KOGYO CO., LTD.
Yuji	OKUTOMO	Director, Director of Construction Department. DORO KOGYO CO., LTD.
Hisao	OOKA	Director, Manager of Osaka Branch. KITAGAWA ROAD CO., LTD.

ACCOMPANYING PERSON (Mrs.)

Sumiko	FUJIWARA
Maki	HASHIMOTO
Yasuko	WATANABE
Keiko	MORI
Sakuko	ARAI
Shizuko	TSUJI

EXHIBIT 7

Individual Report Letters

List of Canadian Participants

Japan Road Contractors Association Seminar

July 7th, 1986

1. Don Godfrey, Transportation Industry Office, MTC
2. Junette Douglin, Transportation Industry Office, MTC
3. Bill Phang, Research and Development Branch, MTC
4. Dan Lynch, Engineering Materials Office, MTC
5. Don Thrasher, Contract Management Office, MTC
6. Bill Hashizume, Structural Office, Central Region, MTC
7. Brian Hicks, Senior Programs Manager, Roads and Transportation Association of Canada
8. John Emery, President, John Emery Geotechnical Engineering Ltd.
9. Ralph Haas, President, Pavement Management Systems
10. Chuck E. Lawrence, President, Ontario Road Builders' Association
    Huron Paving Company
11. Joe Gurowka, Member, Ontario Road Builders' Association
    Warren Bitulithic Ltd.
12. Paul Ostrander, Member, Ontario Road Builders' Association
    Dufferin Construction
13. Art Ryan, General Manager, Ontario Road Builders' Association
14. Robert Bradford, Executive Secretary, Ontario Hot-Mix Producers Assoc.
15. Earl Kee, Member, Ontario Hot-Mix Producers Assoc.
    Red-D-Mix Concrete Co.,
    (Asphalt Division)
16. Larry Brown, President, Ontario Hot-Mix Producers Assoc.
    Standard Aggregates

Trow Ltd
Consulting Engineers

43 Baywood Road
Rexdale, Ontario, Canada
M9V 3Y8
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November 26, 1984

Dr. John B.L. Robinson, P.Eng.
Director of Technical Programs
Roads and Transportation Association of Canada
1765 Saint Laurent Blvd.
Ottawa, Canada K1G 3V4

Dear John:

In responding to your request for information of potential use during preparation of your PICA 2 workshop report, I would first like to thank you and RTAC for making my participation in the PICA 2 workshop possible. As outlined below, it was an informative, learning experience that will be of continuing help with my research and consulting activities. It was also fun to meet your family and enjoy the social activities with a range of perspectives on Japanese ways and life styles. At least we still can play hockey better than them (at least some teams from Quebec).

I will outline my impression of general benefits to the Canadian side from the consultations with the Japanese at PICA 2 and associated JRCA meeting first (noting there were also a great deal of "internal" benefits within the Canadian group through the week of intensive interaction), and then turn to specific items that I was involved in outside the formal PICA 2 workshop.

As you know, I was asked to prepare a list, during the workshop, of areas for "intensive" study by Canadian/Japanese cooperative specialist groups for PICA 3. While subject to discussions with the Canadian ad hoc committee, this listing with an indication of where the Japanese or Canadian experience is of direct benefit or advantage (noting it is difficult to separate Canadian experience from United States developments) is:

1. reflective cracking
   - temperature susceptibility of asphalt cements and use of modifiers (Canadians currently leading, but Japanese starting to make significant progress, particularly in area of polymeric modifiers that are just starting to be introduced into Canada)
   - analytical and experimental studies of cracking mechanism (Japanese leading, particularly in areas of fracture mechanics and laboratory modeling, with significant work of interest to Canadians, particularly in our activities to analyze geogrids)
   - maintenance and rehabilitation practices to minimize and prevent (area that both countries must continue to develop and exchange information on, with a state-of-the art synthesis developed)
   - materials and materials engineering to prevent (area that both countries must continue to develop and exchange information on, with Canadians ahead in geotextiles and geogrids and Japanese probably ahead in surface planing/scarifier technology)

2. automated data aquisition and equipment
   - Canadians probably ahead, but Japanese involved in a wider range of activities and may have an inherent micro-electronics advantage in the future - a common problem is the lack of uniform procedures to describe distress in terms of type, severity and intensity

3. studded tires, deicing and sanding practices
   - area that both countries must review and develop state-of-the-art synthesis

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Ministry of Transportation and Highways
Engineering
940 Blansnard St.
Victoria
British Columbia
V8W 3E6
Ph: (604)387-1881

YOUR FILE .....
OUR FILE 73-13-04
31-52-KERR

November 20, 1984

Dr. John B. L. Robinson, P. Eng.
Director of Technical Programs
Roads and Transportation
Association of Canada
1765 Saint Laurent Blvd.
Ottawa K1G 3V4

Dear John:

Thank you for your letter of October 31, 1984. Participants in the "Paving in Cold Areas Workshop" have to thank you for your successful arrangements and the considerable efforts you made during the meeting to keep things running smoothly and to cover our various requests for information and services. Your attention to details helped to make the meeting both useful and enjoyable.

I thought this meeting was very useful, not only from the technical content of the papers but also in terms of improved human relationship and understanding of the Japanese culture and thought processes. At Vancouver in 1982, I felt the Japanese side was very withdrawn and defensive, but during this visit on their home turf, they were more friendly and communicative, making a real exchange of views possible.

A number of the papers given at the workshop appeared to be of interest but with the difficulty of interpretation, require more detailed study of the written preprints which have only just arrived here. A number of the Japanese papers on asphalt research and performance would have been more informative with better characterization of the asphalt than penetration at 25°C.

The field trip was very useful to observe the care with which construction was performed and the excellent final product. I also noted an improved automatic screed control on their asphalt pavers and a cement concrete spreader in one of the tunnels which I have not seen before. Apart from the asphalt and concrete paving, I was also

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Dr. John B. L. Robinson, P. Eng.
Director of Technical Programs
Roads and Transportation
Association of Canada

November 20, 1984

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interested to observe their attention to drainage, methods of soil and rock slope protection, debris torrent check dams and bypass channels and the high quality finish on the concrete bridge and tunnel structures.

I would have liked more time and opportunity to visit their laboratory facilities and to get more detailed information on their asphalt mixes, project quality control methods and construction equipment which produced such high quality end products.

Not the least benefit of the workshop was the week of close association and exchange of information with paving specialists from across Canada, most of whom I have known to some degree before.

I believe the Canada - Japan Paving Workshops are useful and that productive parallel or joint research can develop from these contacts.

Thank you again for your input and the opportunity to attend the "Paving in Cold Areas Workshop" in Japan.

J. W. G. Kerr, P. Eng.
Director of Geotechnical
and Materials Engineering

JWGK:esg

4.	thickness design methods and applicability	- area that both countries must review, particularly in terms of drainage and frost penetration influences - it is unlikely that a common method(s) will evolve, but comparisons would be most helpful, particularly in areas of heavy vehicle loadings
5.	distress characterization	- area that both countries must work on to develop a uniform "catalogue" in terms of distress type, severity and intensity (subject of a current RTAC Project Committee) - required for both automated data aquisition and pavement management systems
6.	bridge decks	- area that both countries must work on to develop surfacings for improving ride quality and durability enhancement
7.	pavement maintenance and methods	- area of intensive work by both countries that requires development of a state-of-the-art synthesis
8.	recycling technology, equipment and experience	- Canadians currently leading, not known what the Japanese can contribute - should look at both asphaltic concrete and portland cement concrete recyling
9.	local and regional airport pavement maintenance	- Canadians currently leading, but Japanese have a large local and regional airport system and their technology has not really been considered.

It is perhaps significant that the above listing is reflected to a large extent in the proposed PICA 3 themes - pavement maintenance (pavement management system applications, repairs, and maintenance technology), pavement materials (evaluation, durability, new materials), and analysis of paving materials. Given that these topics involve Canadian and Japanese governmental agencies, universities, contractors and consultants, these groups should all be represented where possible, even on the Canadian/Japanese cooperative specialist

groups. Given that paving in cold climates is also a Scandinavian activity, I believe consideration should be given to some Canadian/Scandinavian activities. If financial/logistical constraints force the cooperative specialist groups to be limited, I would suggest that the areas of reflective cracking, distress characterization and pavement maintenance materials and methods to be of greatest significance and potential benefit to the Canadians. (In this regard, Trow Ltd will support my participation as necessary given the substantial help that participation provides to our company's research and consulting.) The attached RTAC Soils and Materials Committee correspondence indicates both the high regard the Committee has for PICA and plans to keep the Canadians informed.

Turning to my specific contacts/activities in Japan in conjunction with PICA 2 these can be summarized as:

1. Meeting with Toshinori Mizutani, Chief of Tunnel Division PWRI, October 17, to review present status of tunnelling activities in Japan. This has resulted in an exchange of references with specific relevance to extruded tunnel liner systems, a subject Trow is involved in with UTDC.

2. Site visit to Nippon Steel Nagoya Works and lecture to Nippon Slag Association (covered by attached schedule and participants list), October 18/19, to view blast furnace slag and steel slag processing and use, and to describe Canadian experience to them. Valuable information was obtained current Japanese practice, including commercial contacts, and the Japanese slag experts expressed an interest in being involved in future PICA meetings. These two days of meetings have provided us with the latest in Japanese slag technology. Slag utilization technology could certainly form a Canadian/Japanese cooperative specialist group activity. Specific information as slag grinding is being translated from Japanese for a Trow client.

3. Asphalt in rail ballast was covered in general on October 18, and is to be explored further to assist OHMPA and Trow in a proposal to GOALRT.

4. The alkali rock reactivity problem in Japan was discussed October 18. This problem is significant in Canada and apparently being identified in Japan.

Finally, I am writing an article for the Canadian Consulting Engineer on the PICA 2 experience, and will send you a copy in the next week.

Hopefully PICA 3 will develop with full consultant input from both sides.

Best wishes.

Yours sincerely,
TROW LTD

John J. Emery, Ph.D., P.Eng.
Vice-President

JJE/me

University of Waterloo

Waterloo, Ontario, Canada
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Faculty of Engineering
Department of Civil Engineering
519/885-1211

Telex Number
069-55259

November 19, 1984

Dr. John Robinson
Director of Technical Programs
Roads and Transp. Assoc. of Canada
1765 St. Laurent Blvd.
Ottawa, Ontario
K1G 3V4

Dear John:

Report on PICA II Workshop, Tsukuba, Oct. 15-19, 1984

The purpose of this report is to summarize my observations and recommendations regarding the Workshop. It is subdivided into background, general observations, contacts and participation, the benefits to Canada and future activities worth pursuing plus recommendations. In this way, I hope the report can also be a stand-alone document for potential distribution to our Pavement Technical Committee, and any other interested RTAC Committees or individuals.

Background

The first Paving in Cold Areas (PICA I) Workshop was held in Vancouver in Oct., 1982, as an outcome of prior Canada/Japan Science and Technology Consultations. It involved about 30 Canadians and 18 Japanese. The primary purpose was to exchange information on such topics as low-temperature cracking, effects of soil freezing and frost penetrations, reflection cracking, prevention of frost heave, characteristics of paving materials and asphalt additives. Two volumes of Proceedings, incorporating 22 papers, were published and these remain as a valuable information or reference base in the subject area.

It was agreed that the first Workshop was a success and that a second one was warranted. After two years of planning and organization the PICA II Workshop was held in Tsukuba Science City in Japan, Oct. 15-19, 1984. The purpose and scope of this workshop were somewhat broader than PICA I in both technical content and the desire to establish a basis, if possible, for future joint research and commerical activities.

About 14 Canadians and more than 40 Japanese participated in PICA II. The Canadians travelled to Japan as a group and most were able to take part in a two-day post-workshop field trip. The Workshop Proceedings

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have been published and contain 34 papers, which again provide a very valuable information base for researchers, industry and road authorities. Topics range from various aspects of pavement management to materials and structural design technology. A list of the papers is appended to this report. The breadth of pavement technology represented by these papers is quite noteworthy. The "quality" is also very high.

Some General Observations on Organization, Participation and Presentations

1. The organization of the workshop and all associated activities was superb. Nothing was left to chance and the Japanese were most courteous and gracious hosts.

2. Canadian participation was very enthusiastic, as reflected by the discussion periods. While the Japanese seemed most interested, they were reticent in asking questions during discussion.

3. The efforts of the translators were commendable but there is difficulty in rapid translation of English to Japanese, or vice versa. Consequently, the presentations had to be highly abbreviated (compared to normal) and very slow in order to allow the translators to keep up. This was somewhat awkward and many presentations were substantially over the 20 minute time limit, with the result that almost all sessions ran late. If PICA III is held, such potential problems should be taken into account.

4. The Canadians tended to use slides in their presentations while the Japanese used overhead transparencies. Some lack of quality occurred in both. In my opinion slides are preferable. But, a clear set of "rules" (similar to those issued by TRB) should be issued and slides reviewed for acceptability before presentation if at all possible.

Contacts and Public Agency vs. Private Industry Participation

Some of the contacts made by Canadians were renewals of previous ones (in my own case, for example, with such people as Dr. Kasahara of The Hokkaido Institute of Technology who was a Visiting Professor at Waterloo for a year, with Dr. Sugawara of Hokkaido University and Dr. Kubo of The Hokkaido Development Bureau who have visited Waterloo, with Mr. Iijima of the Public Works Research Institute and others). In addition, new contacts occurred with workshop participants who were not at PICA I in Vancouver. All of these should be valuable for continuing technical information exchanges and occasional visits.

Because Japanese participation in the workshop consisted essentially of only public agency and University people, contacts with industry people were made only at an afternoon seminar (Oct. 16) at the Tsukuba Daiichi Hotel, sponsored by The Japan Road Association and The Japan Road Contractors Association, and at evening social functions including one after the seminar noted and also sponsored by the two industry associations noted. The

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Seminar was devoted to a description of three types of high speed road survey devices either in use or under development by private industry in Japan, and to a summary of Japanese recycling practices.

I had the opportunity some months ago of being briefed on these devices when some of the industry people visited Waterloo. Further comments and recommendations on the potential of this equipment and our potential involvement will subsequently be contained in this report.

The Seminar noted above was held at a hotel away from the Public Works Research Institute conference room for the workshop (which would have been more convenient). Also, the document describing the three devices and the Japanese recycling practices, which was distributed at the Seminars was conspicously devoid of references to the companies concerned. There seems to be a reluctance or reservation about associating such private industry with the public agencies involved in the workshop, or indeed having their participation. While there may be good reasons for this from the Japanese viewpoint, it is certainly at variance with usual Canadian practice where we seek to involve private industry (as reflected in the composition of the Canadian delegation).

If we are to realize the full potential (including commercial activities) of any such future workshops, consultations, etc., then it seems essential that both Japanese and Canadian private industry be involved.

Benefits to Canada, and the Recognition of Some Realities

A number of direct and indirect benefits to Canada have resulted from the Workshop, contacts, observations, etc. They include the following (not in order of importance):

1. Opportunity to observe the state of Japanese pavement engineering technology.

2. Opportunity to bring together, in an organized form, some of our own pavement technology.

3. Opportunity for first hand observations of Japanese road conditions (geometrics, pavement surfaces, safety, traffic, construction and maintenance practices, etc.).

4. Making contacts (as previously noted).

5. Providing a basis for future technology exchanges, and the possibility of joint commercial activities.

6. Ideas and new technical information from the Japanese research papers in The Proceedings. (such as Dr. Sugawara's work on Thermal cycling).

While the foregoing benefits can be identified, we should clearly recognize that there are also some benefits to Japan. The realities of this are that, notwithstanding the research ideal of disseminating knowledge, the Japanese are particularly adept at putting tremendous energy, effort and organization into bringing an idea, a piece of knowledge, a method, a device, etc., into full operational and marketing potential. For example,

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in this workshop, there are at least two Japanese papers that have apparently used the RTAC "Pavement Management Guide" to great advantage (as illustrated by the text, diagrams, etc.). In fact, I was told by a number of people at the workshops that the RTAC Guide is a very valuable, well used document, as is the Haas-Hudson book on the same subject (neither book is referenced, however, in any of the papers). As another example, the automated, high speed surveying methods of pavement surface condition, as developed and used by consultants in Canada over the past 7 or 8 years have been of great interest to the Japanese (which I have personally been told) and have undoubtedly been very useful to them in developing their own, more recent devices (again, however, I find no references to the earlier Canadian work).

The "lesson" for us is that while we should not be restrictive in disseminating our knowledge and technology, there has to be a quid pro quo situation of receiving the like in return.

Another reality is that, in a commercial sense, we are not likely to "sell" any of our technology, equipment, etc. into the Japanese market. Rather, we should strive, where possible, to work with Japanese public and private agencies to jointly develop and market such technology and equipment in other countries (see the next section for a recommendation in this regard).

Activities Worth Pursuing and Recommendations

There are two major types of activites worth pursuing:

1. Continued exchanges of technical information (i.e., PICA III, etc.)

2. Joint development of technology and equipment for commercial purposes.

The first activity can probably best be realized through future PICA type activities plus intervening technical exchanges, visits, consultations, etc. (for example, I have an engineer from the Public Works Research Institute in Tsukuba currently completing his graduate work with me at Waterloo, and another one may be here in the near future). However, if a PICA III is held, there should be private sector participation on both the Japanese and Canadian sides.

The second type of activity holds some real potential. It is my opinion (reinforced by the Seminar of Oct. 16 previously referred to, plus visits to us here in Canada by the same private industry people) that the Japanese have developed some very good hardware for high speed, automated surveying of pavement roughness, condition, etc. However, they lag behind us in the development of software and the applications technology. For example, they can use lasers and videologging for surveying pavement conditions, but they have not yet developed the image analysis software for successfully using the results in pavement management. Moreover, I believe that the state of their pavement management technology is not as well developed or implemented as is ours. Consequently, joint efforts in hardware-software development and applications could be very beneficial to both of us.

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As a concrete example, I believe that a working agreement could be struck between one or more of the Japanese private industry groups who have developed this hardware and a Canadian group of pavement management experts (who have the software knowledge and the implementation experience) to jointly commercialize and market the technology in North and South America, Europe, Africa and Asia.

In summary, I believe that PICA II was successful and that there were certainly some benefits to Canada. My recommendations are that we should continue the technical information exchanges and that the prospects for joint development and commercialization between Canadian and Japanese interests for high speed, automated acquisition of pavement management inventory data is worth pursuing. We should, however, only continue these activities if Japanese private industry is brought in and we should build in a mechanism for ensuring that any future benefits to Canada are worthwhile.

Sincerely,

Ralph Haas, Ph.D., P.Eng.
Professor and Chairman

RH/sk

Enclosure

cc Bill Phang

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December 3, 1984

John B. L. Robinson Ph. D. P. Eng.
Director of Technical Programs
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Our File: RTAC - PICA

Dear John:

I was honoured to participate in PICA II workshop in Tsukuba Science City this past October. I beleive that the exchange with the Japanese is of benefit to the Canadian Paving community.

The benefits of this exchange program are both technical and opportunity to expand works translated from Japanese to English and vice versa.

The three areas that I found a valuable exchange were the mathematical modeling of both pavement performance and pavement materials. The Japanese research on improved asphalt is a second area of new information and potential joint activity. The third area is Japanese electronic abilities to develope automatic data collection systems.

The Japanese presentations on mathematical modeling will be of benefit to further develope our pavement management information systems and understanding of paving materials behavior.

The work presented on improved asphalts using materials such as ground rubber, and semi-blowen asphalts. The improvement of asphalts using rubber, plastisized and chemical improvements is an area where joint research could be carried out as the problems being addressed are the same in both countries.

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The work done by the Japanese on automated pavement data collection seems to be quite parallel to work done in North America. The data collection systems are similar and collect parallel items of data. We have some better system concepts than the Japanese but not the ability to develope these on our own. With some joint projects in this area would speed up the development and also produce a joint market to make the collection systems economically viable to put into production.

In a general observation I was very impressed with the quality of the Japanese construction on their expressways. The detail that goes into their conference planning also shows through in their construction. The construction project we visited in the field trip was an excellent example of quality that can be achieved. The hospitality of PWRI and all other Japanese contacts was impressive.

Yours truly,

G. H. Heiman

G. H. Heiman P. Eng.
Surfacing Engineer

GH/gm: 2128A

c.c. M. F. Clark

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November 21, 1984

John B.L. Robinson, Ph.D., P.Eng.
Director of Technical Programs
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Dear John:

This letter has been delayed because I was required to travel to the U.S. upon arrival from Japan. Please accept my sincere appreciation and thanks for the opportunity to participate in PICA II. I acknowledge the contribution by the sponsor in the form of a travel allowance which has been, in my opinion, a worthwhile investment.

The technology status of the Japanese paving industry in general impressed me as advanced and progressive. Government support and participation in technology development, acquisition and exploitation appears to be greater than in Canada. The efficient employment of technology, especially in terms of resource optimization for improved performance and serviceability, was also apparent.

A specific subject area that would benefit Canadian paving engineers and technologists directly is the reduction of thermally induced reflection cracking. This mode of premature pavement cracking is a significant problem, common to both countries, and Japan could contribute with their expertise and experience.

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Tensar

Following the organized workshop meetings and field trip, I had two separate meetings that proved quite interesting and of mutual benefit.

(1) Visit to Mitsui Petrochemical Industries Ltd. in Tokyo for a presentation and discussion of pavement reinforcement technology with Tensar products.

(2) Meeting with Nippon Hodo Co. Ltd., largest paving contractor in Japan, who showed interest in pavement reinforcement by Tensar grid.

On a private note, I also had the opportunity to visit with an old classmate from my student years at the University of Alberta, who is now Professor at Tokyo Institute of Technology.

The technology exchange visit to Japan was for me a pleasant and unique experience and absolutely worth the effort. In concluding, I will most likely not be alone in recommending that these science and technology consultations between Japan and Canada be continued.

Sincerely,

Gerhard Kennepohl
Manager
Pavement Reinforcement Technology

GJK/is